Chapter 1

Introduction

1.1 Introduction:-

In criminal investigations, suspects can often be identified and brought to justice through face sketches created based on eyewitness descriptions. However, in today's era of technological advancement, traditional hand-drawn sketches have proven to be less effective and time-consuming, especially when it comes to matching and identifying individuals from existing databases or real-time sources.

Historically, several methods have been proposed to convert hand-drawn sketches into formats suitable for automated identification. Despite their intent, these methods often failed to deliver accurate or reliable results. Applications designed to create composite face sketches also emerged, but they came with their own set of limitations—such as restricted facial feature libraries and a cartoon-like appearance of the generated sketches. These limitations reduced the practicality and effectiveness of such tools in real-world investigative scenarios.

These challenges inspired the development of our application, designed to go beyond the conventional approach. Unlike earlier tools that offered a limited set of pre-defined facial features (eyes, nose, mouth, etc.), our platform allows users to upload hand-drawn individual facial components. These components are then seamlessly integrated into the application's feature set, enabling the creation of sketches that closely resemble original hand-drawn illustrations. This feature significantly enhances the usability and adaptability of the platform for law enforcement agencies.

Moreover, our application supports the direct upload of previously drawn facial sketches—enabling the system to utilize advanced deep learning algorithms and robust cloud-based infrastructure to perform suspect identification and recognition with higher accuracy and speed. This approach not only modernizes the traditional sketch-based identification process but also makes it more efficient and effective for modern law enforcement needs.

1.2 Organization of the project:

Chapter 1 introduces the motivation and background of the project, outlining its purpose and the structure of the report. It sets the stage for the rest of the document by explaining the concepts.

Chapter 2 provides a review of existing systems, identifying their limitations and gaps that the project aims to address. It also formulates the problem statement, objectives, and scope, establishing the project's contribution to the field.

Chapter 3 focuses on the software models and system design for the project. It discusses the architectural framework, technical specifications, and system requirement specifications (SRS), detailing the project's functionality and design.

Chapter 4 explains the methodology used in the development of the project. It covers the tools, techniques, experimental setup, and technology stack, offering insights into the development process.

Chapter 5 details the implementation of the project, outlining the system flow and modules for face sketch construction and recognition. It discusses the integration of system components and challenges faced during the process.

Chapter 6 presents the results of the project, analyzing the outcomes and evaluating the system's performance. It includes testing data and performance analysis to assess the system's effectiveness.

Chapter 7 concludes the report by summarizing the findings and achievements. It reflects on the project's success and suggests areas for improvement, along with potential future enhancements.

Chapter 2

Literature survey

2.1Existing System Survey :-

Sr. no.	Author Name	Publish Year	Research Paper	Summary
1.	Adimas Aglasia1 , Suhendro Y. Irianto, Sri Karnila, Dona Yuliawati	2021	Image Sketch Based Criminal Face Recognition Using Content Based Image Retrieval	From the results and discussion of this research, it can be concluded that our algorithm is quite good to recognize suspected criminals using image sketches. The effectiveness of retrieval has above average which is 80% in terms of precision. In the near future, research should be carried out by using other methods such as segmentation, pattern recognition, or Support Vector Machine and using a bigger image database.
2.	Sahil Dalala, Virendra P. Vishwakarma a and Sanchit Kumarb	2019	Feature-based Sketch-Photo Matching for Face Recognition	The paper aimed to address the challenge of accurately matching sketches with photos in face recognition systems by introducing a feature-based approach using HOG and GLCM descriptors. The paper aimed to address the challenge of accurately matching sketches with photos in face recognition systems by introducing a feature-based approach using HOG and GLCM descriptors.

3.	N Chandrakanth, Manoj S G, Sugam B K, Suhas K S, Prof. Sandesh R	2022	A Survey Paper on Sketch to Face Recognition by using Machine Learning	Implementing an artificial neural network greatly increases the effectiveness of face component extraction using sketch-based analysis (ANN). Due to the in-depth examination of the features extracted from the image and the creation of a model co-variance matrix to compare the features of the victim resultant, the resultant output will be generated much more effectively and there won't be any inconsistencies.
4.	Sami MAHFOUD ,Abdelhamid DAAMOUCHE, Messaoud BENGHERABI, and Abdenour HADID	2022	Hand-drawn Face sketch recognition using rank-level fusion of image quality assessment metrics	Face Sketch Recognition (FSR) presents a severe challenge to conventional recognition paradigms developed basically to match face photos. This challenge is mainly due to the large texture discrepancy between face sketches, characterized by shape exaggeration, and face photos. In this paper, we propose a training-free synthesized face sketch recognition method based on the rank-level fusion of multiple Image Quality Assessment (IQA) metrics. The advantages of IQA metrics as a recognition engine are combined with the rank-level fusion to boost the final recognition accuracy.

Sr. no.	Author Name	Publish Year	Research Paper	Summary
5.	P. Yuen and C. Man	2019	Human face image searching system using sketches	The paper proposes the Smart Traffic Management Platform (STMP), which integrates heterogeneous big data streams from IoT, smart sensors, and social media to manage traffic effectively using AI .The paper acknowledges the need for further research to fuse data from various heterogeneous sources such as security
6.	Liang Fan, Han Liu, Yuxuan Hou	2019	An Improved Siamese Network for Face Sketch Recognition	The paper aims to propose a robust methodology for predicting software fault proneness using machine learning techniques. It addresses the problem of identifying which parts of a software system are more likely to fail, thus helping in efficient allocation of resources for software maintenance.

Table 2.1 Literature Survey

'Recent research in face sketch recognition has significantly advanced identification systems. Aglasia et al. introduced a content-based image retrieval system using sketches for criminal identification, achieving 80% precision [1]. Dalala et al. proposed feature extraction methods like HOG and GLCM to improve sketch-photo matching accuracy [2]. Chandrakanth et al. discussed ANN models that enhance face feature extraction and reduce inconsistencies through co-variance matrix comparison [3]. Mahfoud et al. suggested a training-free method using image quality assessment fusion to boost accuracy [4]. Yuen and Man integrated sketch-based recognition into traffic systems for real-time identification [5], while Fan et al. designed an improved Siamese network for better sketch-photo recognition [6]. These studies collectively enhance the effectiveness of sketch-based face recognition system

2.2 Problem Statement:-

In this modern age, the overall crime rate is increasing day-by-day and to cope up with this the law enforcement departments too should find ways that would speed up the overall process and help them in bringing one to justice. One such way can be using face recognition technology for identifying and verifying the criminal.

The traditional approach here is to use the hand-drawn face sketches drawn by forensic sketch artist to identify the criminal, modernizing this would mean using the hand-drawn sketch and then matching them with the law enforcement departments database to identify the criminal. Using this approach would result in the various limitations with latest technologies and even would be time consuming as there are very few forensic sketch artists available when compared to the increasing crime ratio.

2.3Objectives:-

1. Develop a Sketch Tool that allows users to create precise face sketches with customizable features.
2. Enhance face recognition capabilities by employing AI to match sketches with criminal databases.
3. Boost efficiency by speeding up the process of suspect identification in law enforcement.

2.4 Scope:-

1. Core Features:

a. Face Sketch Construction: Users can create accurate composite face sketches using predefined features, based on eyewitness descriptions**.**

b. Face Recognition: The application matches these sketches against a criminal database using deep learning, ensuring high accuracy and efficiency.

2. Security:

a. Machine Locking: The app is locked to specific hardware, preventing unauthorized use.

b. Two-Step Verification: Adds an extra layer of security through OTP-based authentication

Chapter 3

Software analysis and design

3.1 Software Model

3.1.1 Phases of the Software model:

Following the ethics of software engineering, any programmable system follows a process. Process modelling attempts to present this in an abstract form, thus representing the business process or workflow of the project. We have explored several process models for our project.

The process model we have chosen is Waterfall Model: The Waterfall Model is a traditional software development methodology that follows a linear and sequential approach. It is divided into several distinct phases, with each phase dependent on the deliverables of the previous one.

Applying the waterfall model to the development of involves breaking down the project into small, manageable increments and delivering functional pieces of the system in short development cycles or sprints.

Here are the typical phases in the Waterfall model:

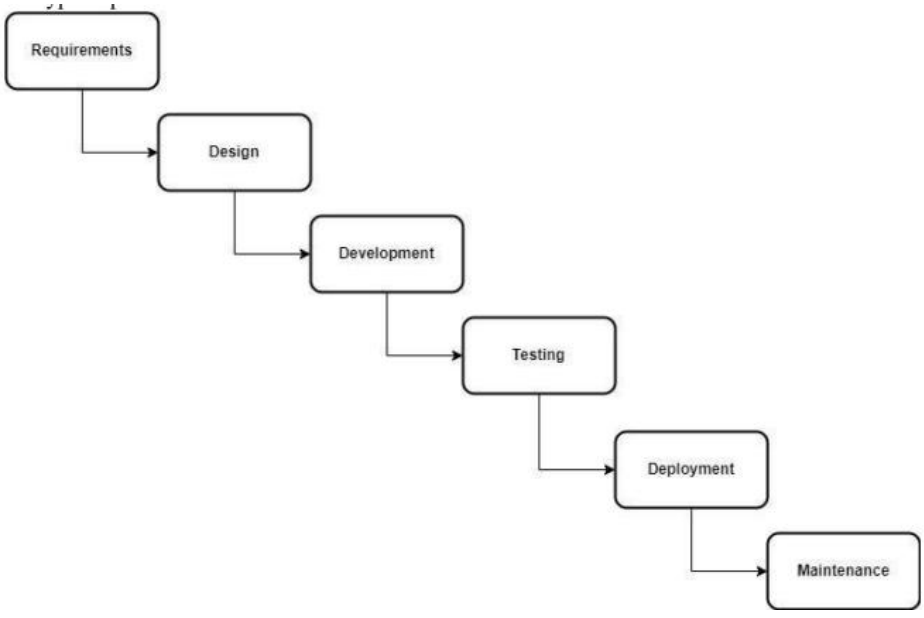


Fig 3.1. Software Model

The above software model illustrates the steps involved in making of project.

3.2.Proposed System:-

The proposed system is a **Java-based standalone desktop application** aimed at assisting law enforcement agencies in the identification of potential suspects through facial sketches. Designed with usability and security in mind, the application features a user-friendly interface and a robust backend that facilitates sketch creation, image processing, and intelligent database matching.

A central feature of the system is its **drag-and-drop interface for modular sketching**. Users can construct facial composites by selecting and arranging individual features such as eyes, nose, mouth, hairstyle, and jawline from a predefined library. This modular approach offers both flexibility and precision, making it particularly valuable when eyewitness descriptions are vague or incomplete.

In addition to modular sketching, the application allows users to **upload hand-drawn sketches**, typically created by forensic artists. These images are automatically preprocessed and normalized to a consistent format before being passed through a deep learning pipeline for matching.

At the core of the system lies a **Convolutional Neural Network (CNN)** model, which is trained to analyze and compare sketch inputs with a database of real facial photographs. The model extracts high-level features from both sketches and images, computes similarity scores, and suggests potential matches, effectively automating a traditionally manual and time-consuming process.

To ensure centralized access and data reliability, the system is integrated with **Amazon Web Services (AWS) S3 cloud storage**. All sketches and match results are stored securely in S3 buckets, enabling scalability and remote access for authorized personnel across various locations.

Security is a critical aspect of the system. It implements **two-factor authentication (2FA)** during login, requiring either email verification or a one-time password (OTP) to ensure that only authorized users can access the application. This feature prevents unauthorized copying or use of the application on other machines, thereby enhancing operational security.

3.3.System Requirement Specifications:-

A.Functional Requirement:-

i) Facial Feature Selection:

- Features must be categorized for easier navigation.
- Drag-and-drop functionality for constructing the face sketch and the user should be able to move the feature around the canvas freely.

ii) Face Sketch Construction:

- The application must enable users to combine selected features into a composite face sketch.
- Users must be able to preview the complete face sketch before saving or downloading.

iii) Download and Upload of Sketch:

- Once the sketch is completed, users must have the option to download the image in a suitable format (e.g., PNG, JPEG).
- Users must be able to upload the sketch to the face recognition module for analysis.

iv) Face Sketch Recognition:

- The face recognition module must allow users to upload a face sketch image.
- The system must compare the uploaded sketch against a database of existing criminal records using Convolutional Neural Network (CNN).
- If a match is found, the application must display the details of the identified individual (e.g., name, criminal history).
- If no match is found, the system must prompt users to add the new criminal's details to the database.

v) Criminal Database Management:

- The application must maintain a database of criminals stored in an AWS S3 bucket.
- Authorized users must be able to add new entries to the database, including face sketches and relevant criminal information

B.Non-Functional Requirements:-

i) Performance:

- The system should process face recognition queries within a reasonable time (e.g., under 3 seconds for sketch matching).

ii) Reliability:

- The system should correctly identify the criminal based on the sketch provided by the user and provide information stored in the database if the criminal is a repeat offender

iii) Security:

- User data, including criminal records and sketches, must be securely stored in the AWS S3 bucket.
- Strong authentication mechanisms, such as multi-factor authentication, should be in place to prevent unauthorized access to the system.

iv) User Interface (UI) Simplicity:

- The user interface must be intuitive and easy to navigate, requiring minimal training or instructions for new users.

3.4 Design

3.4.1. Gantt Chart

A Gantt chart is a type of bar chart that illustrates a project schedule. This chart lists the tasks to be performed on the vertical axis, and time intervals on the horizontal axis. The width of the horizontal bars in the graph shows the duration of each activity. Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project.Gantt charts are usually created initially using an early start time approach, where each task is scheduled to start immediately when its prerequisites are complete.

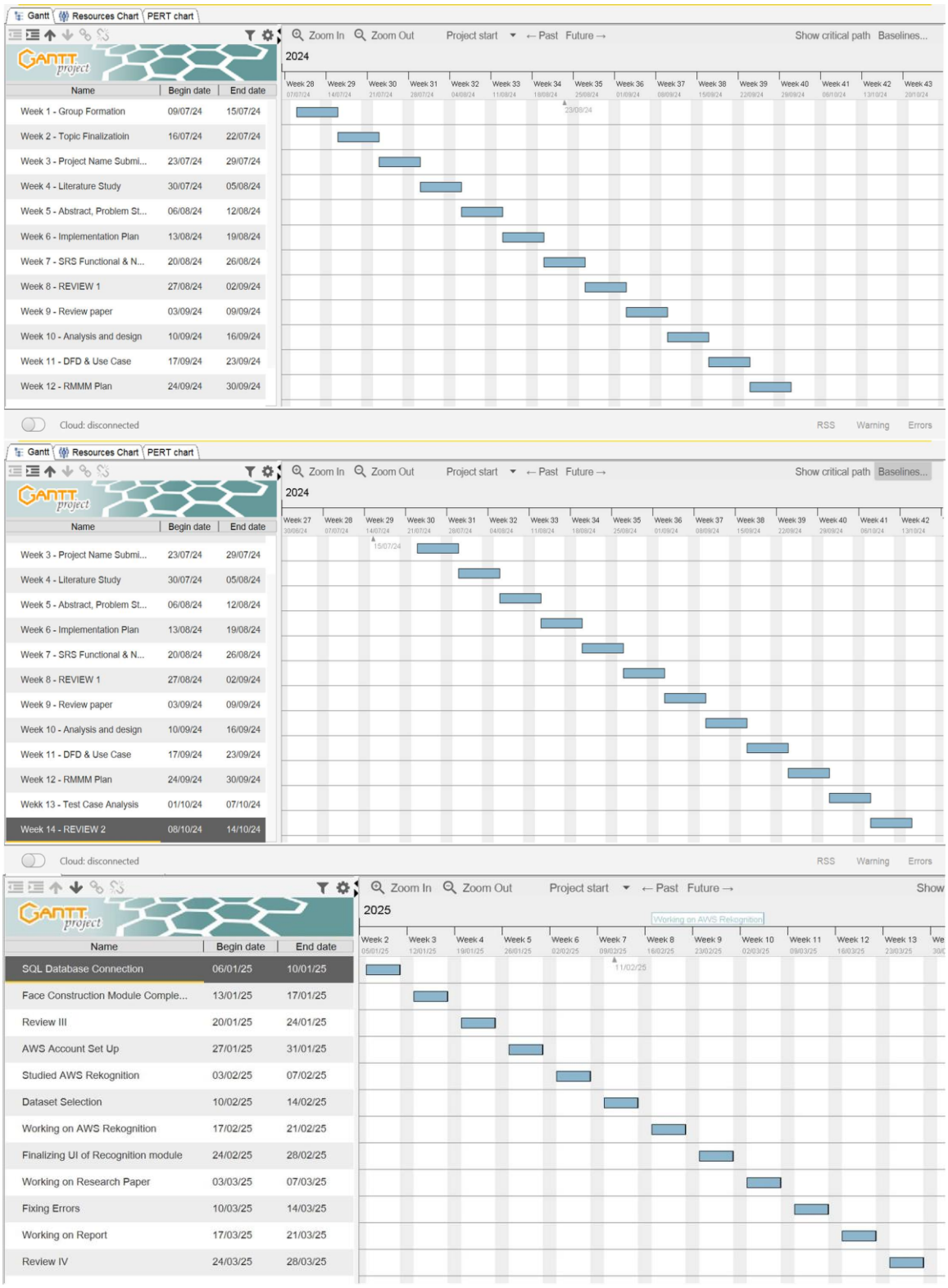


Fig 3.2 Timeline chart

This above Gantt chart illustrates a project schedule.

3.4.2.Data Flow Diagrams

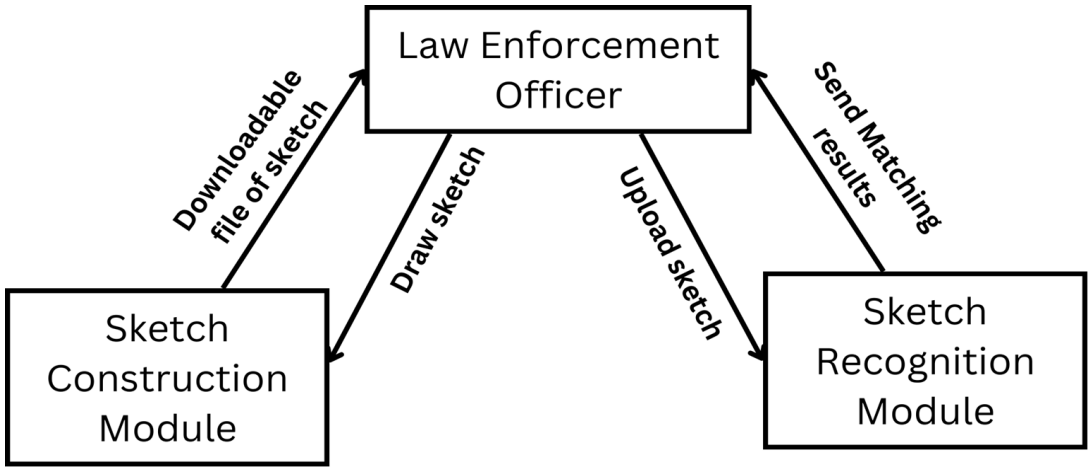


Fig 3.3 DFD Level-0

Provides a high-level view of how a law enforcement officer interacts with the sketch construction and recognition modules.

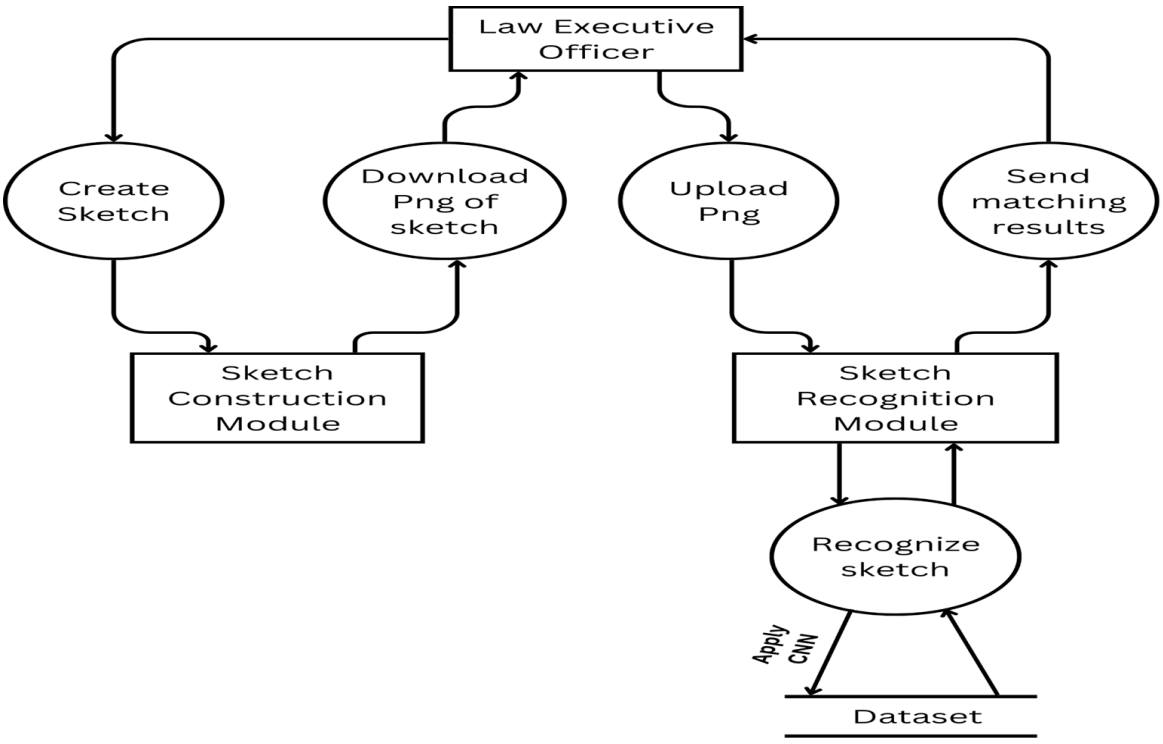


Fig 3.4 DFD Level-1

Breaks down the main system into subprocesses like creating, downloading, uploading sketches, and recognizing them using CNN.

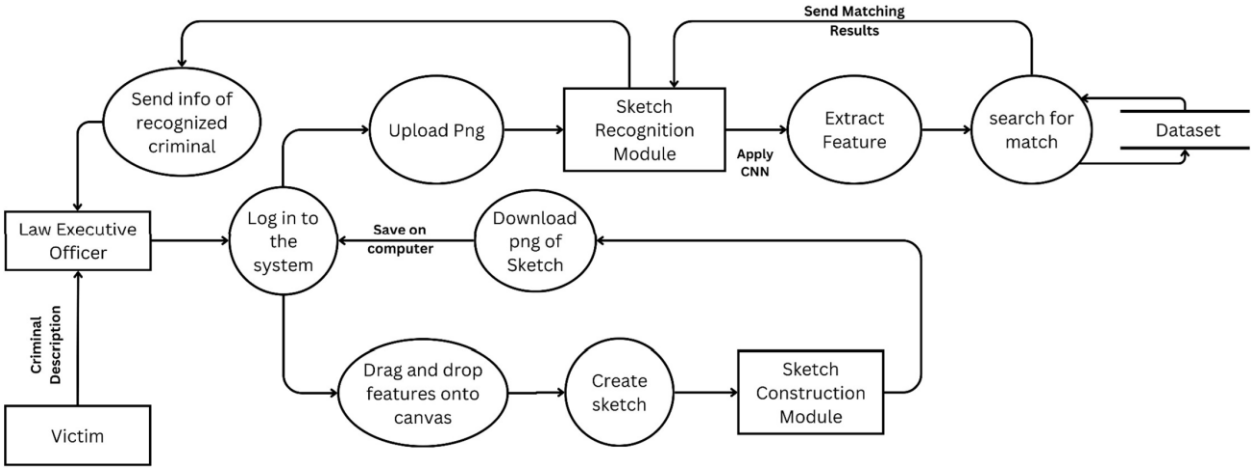
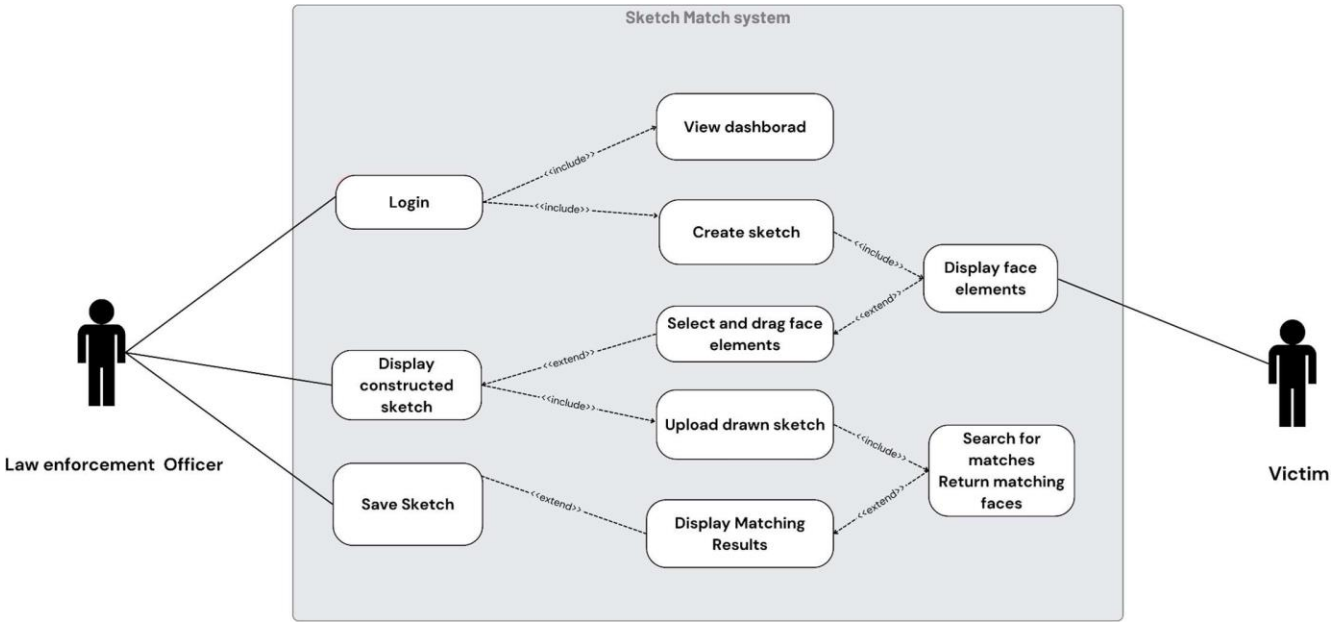


Fig 3.5 DFD Level-2

Details the complete sketch recognition workflow from victim's input to identifying the criminal using feature extraction and dataset matching.

3.4.3. Use Case Diagram



3.6 .Use Case Diagram

This above use case diagram visually represents the interactions between users (actors) and a system, showing the system's functionality from the user's perspective.

3.4.4. Sequence Diagram

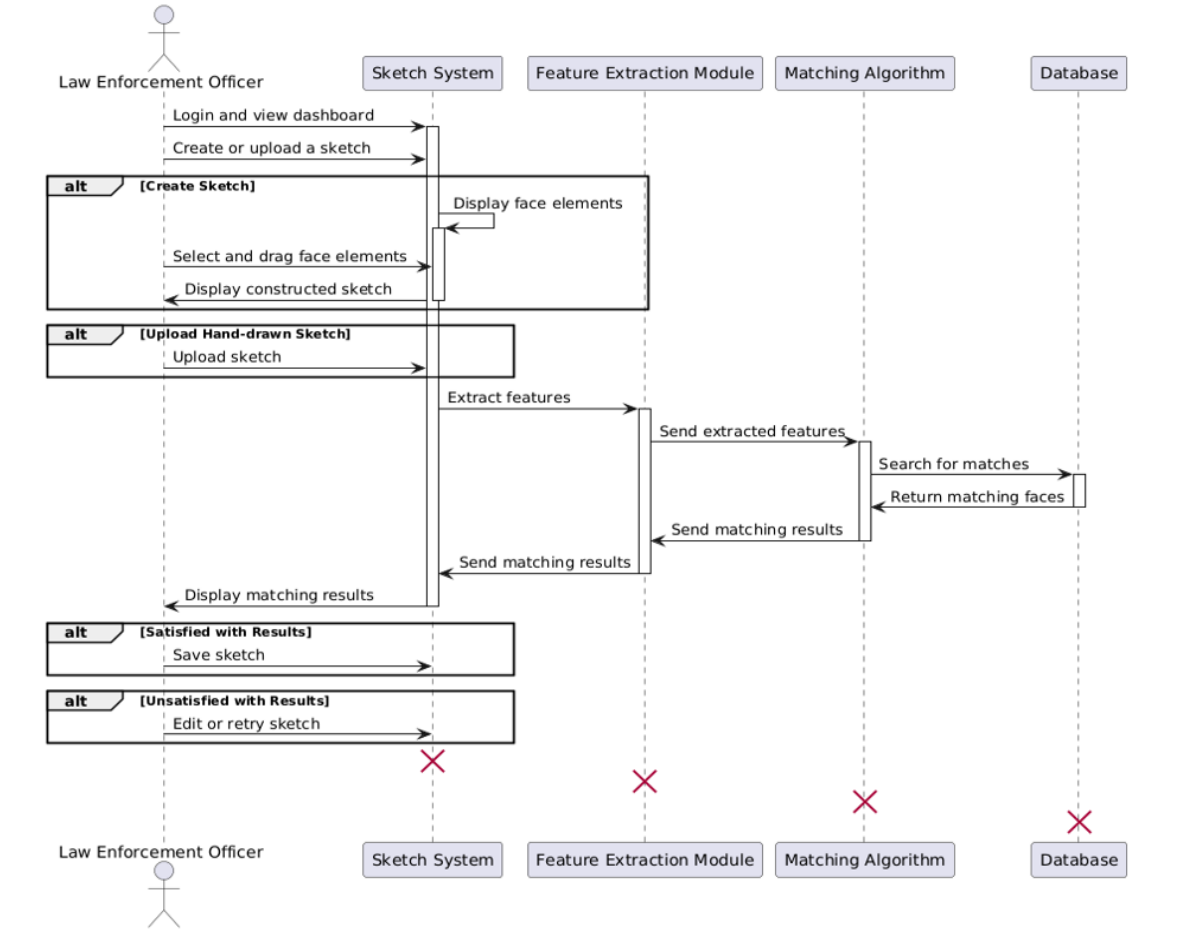


Fig 3.7 Sequence Diagram

The sequence diagram visually represents the interactions between key actors and components in the Sketch System, which include the Law Enforcement Officer, the Sketch System, the Feature Extraction Module, the Matching Algorithm, and the Database.

3.5 Risk Mitigation Monitoring and Management Plan

1. Technical Risks

- **System Scalability**: Potential performance degradation under high user load with extensive database use.
- **Data Security**: Risk of compromising confidentiality during sketch creation and storage.
- **Compatibility Issues**: Difficulty ensuring smooth functionality across various devices and platforms.

Mitigation Strategies:

- **Thorough Testing**: Conduct comprehensive testing using diverse sketch inputs and edge cases.
- **Cross-Platform Validation**: Ensure compatibility by testing across different operating systems and devices.

2. Project Management Risks

- **Scope Creep**: Expansion of project scope due to the need for an increasingly comprehensive database.
- **Timeline Delays**: Potential delivery delays influenced by the availability and quality of victim information.

Mitigation Strategies:

- **Clear Requirements**: Define, document, and communicate detailed project requirements early.
- **Regular Reviews**: Schedule periodic scope and timeline reviews, with change control processes in place.

3. Operational Risks

- **Data Accuracy**: Use of inaccurate, outdated, or insufficient information about the suspect.
- **User Adoption**: Resistance from police or stakeholders used to traditional identification methods.
- **Maintenance and Support**: Difficulty in continuously updating and improving system performance.

Mitigation Strategies:

- **Regular Updates**: Establish a process for continuous data validation and updates.
- **Market Research**: Perform thorough research to build a highly reliable and intelligent database.
- **Marketing Strategy**: Develop and execute awareness campaigns targeting key user groups (e.g., law enforcement agencies).

4. External Risks

- **Regulatory Changes**: New laws or regulations affecting data protection, privacy, or infrastructure.
- **Third-Party Failures**: Dependency on external services (e.g., servers, internet providers) introduces risk of downtime.

Mitigation Strategies:

- **Adaptation Plan**: Stay updated with regulatory shifts and adjust systems to remain compliant.
- **Redundancy Measures**: Implement backup systems and contingency plans to ensure uninterrupted service

Chapter 4

Methodology

4.1 Methodology Used

4.1.1 Description of Data

In this section, describe the data used for your facial sketching and recognition system. This includes:

- **Data Source**: Where and how the data is collected (e.g., police records, databases, victim photos).
- **Data Types**: Types of data used (e.g., facial images, sketch datasets, metadata).
- **Preprocessing**: Any steps taken to clean, organize, or preprocess the data before it is used in the system (e.g., normalization, augmentation).
- **Data Quality**: The quality and accuracy of the data used, including how missing or incomplete data is handled.

4.1.2 Tools and Technology Used

This section outlines the specific tools and technologies used to develop and implement the facial sketching and recognition application.

- **Programming Languages**: Java, JavaFX, and Gluon Plugin.
- **Machine Learning Framework**: Convolutional Neural Networks (CNN) for facial recognition.
- **Cloud Services**: AWS S3 for data storage and management.
- **Libraries and APIs**: Any libraries used for data processing, image manipulation, or other specialized tasks.

4.1.3 Experimental Setup

i) Hardware Specification

Client / Node Machine

- **Processor**: Intel Core i3 (10th Gen) or AMD Ryzen 3 or higher
- **RAM**: 4 GB or more (8 GB recommended for smooth performance)
- **Storage**: 256 GB SSD or 500 GB HDD

Server Machine

- **Processor**: Intel Core i5 (10th Gen) or AMD Ryzen 5 or higher
- **RAM**: 8 GB or more (16 GB recommended for server operations and ML processing)
- **Storage**: 1 TB SSD or high-speed HDD

2) Software Specification

Client / Node Machine

- **Operating System**: Windows 10 or 11 / Ubuntu 20.04 LTS or higher
- **Framework**: Java Development Kit (JDK) 17 or newer
- **Cloud Integration**: AWS CLI v2 (latest stable version)
- **Additional Tools**:
    - JavaFX SDK for GUI development
    - IntelliJ IDEA / Eclipse as the development environmen

Server Machine

- **Operating System**: Windows Server 2019 or 2022 / Ubuntu Server 20.04+
- **Framework**: Java Development Kit (JDK) 17 or newer
- **Cloud Integration**: AWS CLI v2, integrated with AWS SDK for Java
- **Database**: **SQLite** for lightweight storage.

4.2 Technology Stack

4.2.1 Machine Locking:

The Machine locking technique would ensure that the application once installed on a system could not be tampered and could not been operated on any other system, for which the application uses two locking parameters i.e. one software and one hardware locking parameter.

HD ID – Volume serial of hard-drive with OS.
NET ID – Hardware ID – MAC Address.

4.2.2 OTP (One Time Password):

Law enforcement users will log into the application using official email IDs and a one-time password (OTP) sent to their mobile or desktop device for added security. OTPs are randomly generated codes used for single login sessions or transactions, offering stronger protection than traditional passwords. These codes are generated using the HMAC algorithm with either time-based (TOTP) or event-based (HOTP) factors. OTPs can be delivered via SMS, email, or secure apps, but due to vulnerabilities like SMS spoofing and man-in-the-middle attacks, experts—including NIST—recommend avoiding SMS-based OTPs in favor of more secure delivery methods.

4.2.3 JAVA:

Java is a versatile, object-oriented programming language and platform first released by Sun Microsystems in 1995, known for its portability, security, and reliability across devices and systems. It enables cross-platform development through bytecode executed on the Java Virtual Machine (JVM), and supports features like multithreading, networking, and multimedia. Java's maturity makes it stable and predictable, with robust development tools like Eclipse and NetBeans. Its compatibility with languages like Scala and Groovy, along with ongoing updates like Java 8's IoT capabilities and improved APIs, keeps it valuable in modern software development.

4.2.4 JAVAFX:

JavaFX is a powerful set of Java-based graphics and media packages that enables developers to create rich, cross-platform client applications with modern user interfaces. It supports customizable UI design using CSS, FXML, and Scene Builder, allowing clear separation of logic and presentation. Key features include built-in UI controls, WebView integration, Swing interoperability, multitouch support, and hardware-accelerated graphics. JavaFX also offers a high-performance media engine, Canvas API for custom drawing, and a self-contained deployment model. Ideal for building interactive, multimedia-rich applications, JavaFX blends design flexibility with robust Java functionality.

4.2.5 Centralized Computing (Aws For Now):

Centralized computing is a model where all processing occurs at a central computer, with users accessing it via terminals or thin clients connected locally or over a network. It offers enhanced security and easy session recovery, as all data and applications reside on the central system. However, it depends entirely on the central computer—if it fails, the whole system becomes inaccessible. Its effectiveness also hinges on the quality of administration and resources provided, making strong centralized support both a potential weakness and a major advantage.

Chapter 5

Implementation

5.1 System Flow:

Our Application would be majorly used by the Law Enforcement Departments in order to reduce the overall time required to bring the criminal to justice and even to enhance the workforce and speed up the system by keeping accuracy in mind. So, keeping this scenario in mind the platform is designed to be as simple as possible in order to make sure that a user can create a sketch in the application without a formal training.

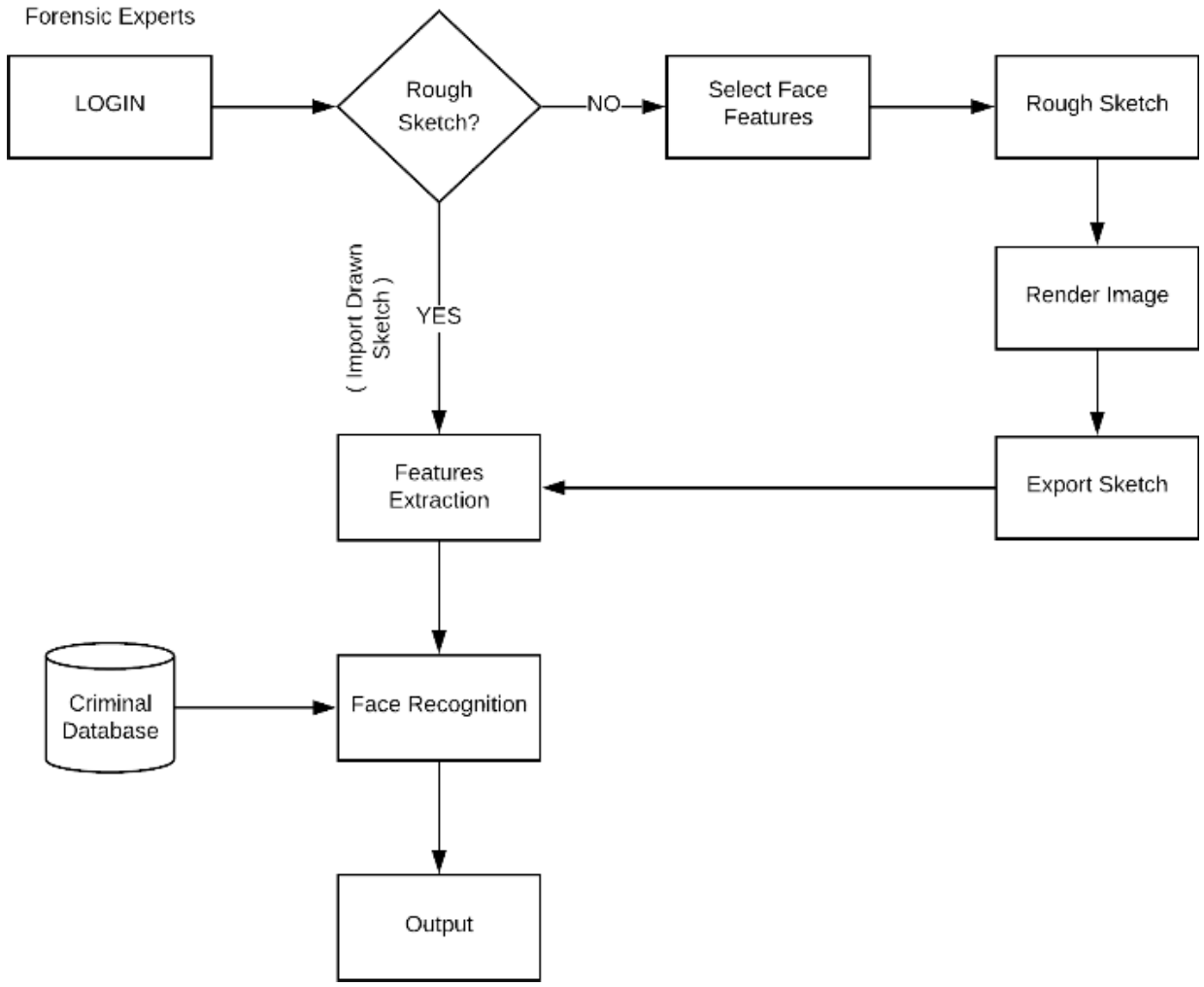


Fig 5.1 System Flow Chart of the Application

The above flowchart represents the overall flow of the system starting with the login page to the actual results been displayed after the sketch is been matched by the records in the database.

The privacy and security are been kept in mind from the very first stage itself starting with the login page itself, the login page consists of two parts. At the start the login page fetches the Mac Address along with IP Address and HDD ID which is then been matched with the data been collected while installing the platform in the host machine and if the data does not match the platform would lock itself and won't allow the user to move further and use any feature of the platform. This would make sure that the platform could not be accessed when the host machine is been tampered or the hard-disk is been tampered to be used in other machine making it more secure and much more reliable than any other platform currently available

. Moving further the second part consist of authenticating the user which consist of making sure that the user accessing the platform can have total privacy and security with the data and their credentials, for this we made use of Two Step Verification where in the user when enters his/her credential on to the platform the platform checks the authenticity of the user after which the platform mails an OTP to the registered email id making sure that no one other than the verified user can access the platform even if they have the login credentials. The OTP is been generated real-time for every login.

After the secure login on to the platform and moving further the platform uses something called as Backward Compatibility, this feature is been introduced in order to make a smooth transition from the current technique on to the new platform. The current technique been the use of hand drawn sketch been drawn by an expert forensic artist with years of experience and then the sketch been used by the law enforcement department to be showed on to various platforms in order to create a sense of awareness in people in order to find someone to recognize the suspect. So backward compatibility allows the law enforcement department to upload those hand drawn sketches on to the platform in order to use our face recognition module and match the suspect sketch with the large record and reducing the overall time and the efforts used in the previous age-old technique.

5.1.1 Face Sketch Construction Module

This module enables the creation of facial sketches based on eyewitness descriptions, without requiring users to have prior sketching experience**.**Our Application would be majorly used by the Law Enforcement Departments in order to reduce the overall time required to bring the criminal to justice and even to enhance the workforce and speed up the system by keeping accuracy in mind. So, keeping this scenario in mind the platform is designed to be as simple as possible in order to make sure that a user can create a sketch in the application without a formal training.

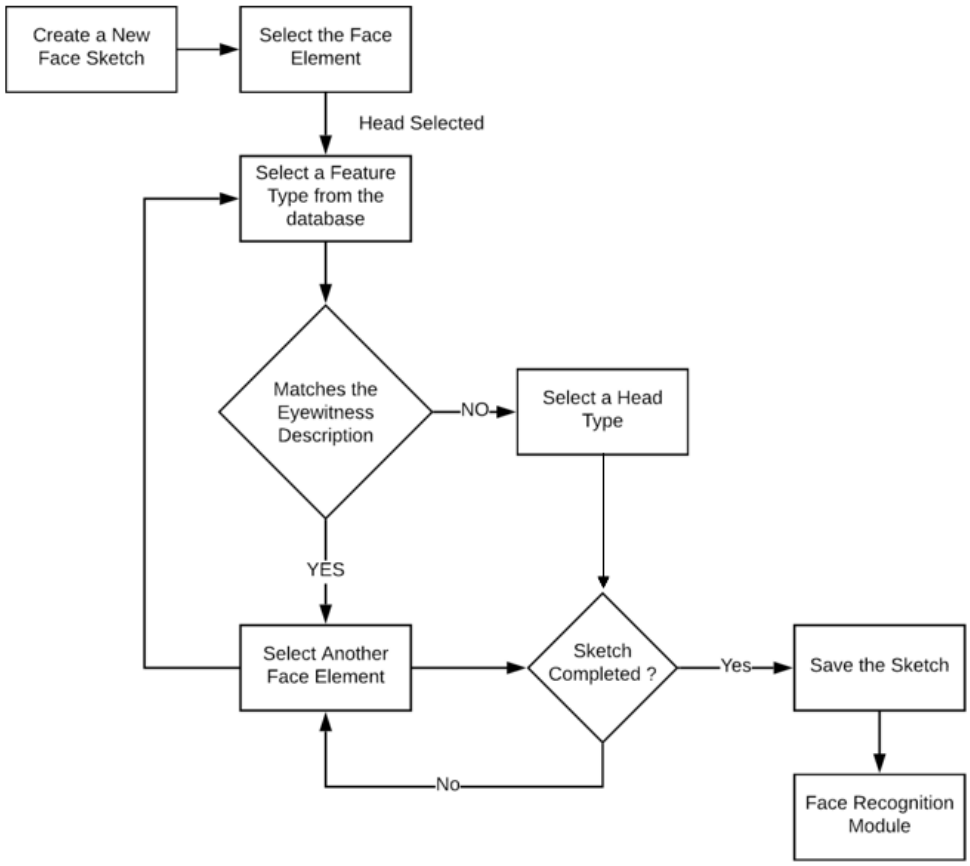


Fig 5.2 Flow Chart for Creating a sketch in the application

The above flowchart illustrates the steps involved in the constructing a face.

The above flowchart illustrates the users flow been followed by the platform to provide an construct accurate face sketch based on the description, the dashboard is designed simple in order to encourage no professional training to go through before using this platform already saving the timeframe which would have been taken a lot time and resources of the Department.

The dashboard of the application is designed around five primary components to ensure a user-friendly and efficient experience. At the core of the interface lies the **Canvas Area**, which serves as the main workspace where users can place, arrange, and modify facial elements during the sketch creation process. This central location allows for intuitive interaction and visual clarity while constructing the suspect's face.

To the left of the canvas, the **Face Categories Panel** provides a structured and categorized list of facial features. These categories—such as eyes, nose, hair, and head shape—are organized to streamline navigation and assist users in locating specific facial components based on descriptions provided by eyewitnesses. This categorization eliminates confusion and enhances the usability of the platform.

Once a user selects a face category, the **Feature Selector Panel**, located on the right side of the dashboard, displays various feature options within that category. Users can browse through these variations and choose the one that most closely aligns with the eyewitness's account. The selected features can be dragged and dropped directly onto the canvas, where they can be repositioned as needed.

The platform also adheres to specific **Element Placement Rules** to maintain anatomical consistency and improve the accuracy of the sketch. Each facial feature is associated with a predefined layer and placement logic—for example, eye elements are automatically positioned above the head element, regardless of the sequence in which they are added. This ensures the final sketch maintains a realistic and coherent structure.

Finally, the **Functional Buttons Panel**, also located on the right, includes essential tools that enhance the usability of the dashboard. These functions include the ability to erase individual elements, clear the entire canvas to start a new sketch, and save the completed sketch. The saved output is stored in PNG format, allowing it to be easily shared or archived either locally on the host system or on secure law enforcement servers.

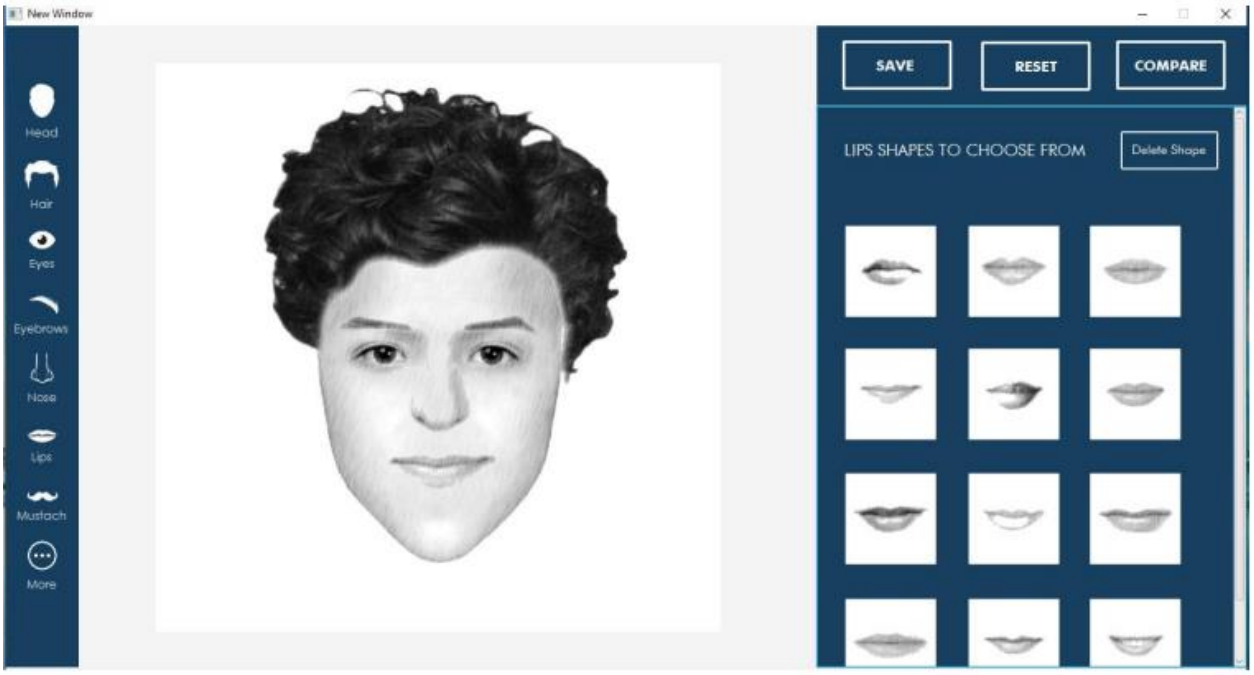


Fig 5.3. A Complete Face Sketch in Dashboard

The Complete Face Sketch been displayed on the Dashboard Canvas.

This figure displays a finalized sketch built using the platform. Such sketches can be exported for distribution via social media, print, or other channels.

5.1.2. Face Sketch Recognition Module

This module processes and matches face sketches—either drawn on the platform or uploaded—against law enforcement databases with high accuracy.

Preprocessing of Existing Records

Before matching can occur, the existing photo records are preprocessed. The platform analyzes each face image, breaks it into identifiable features (e.g., eyes, jawline), and assigns a unique ID to each feature for efficient comparison.

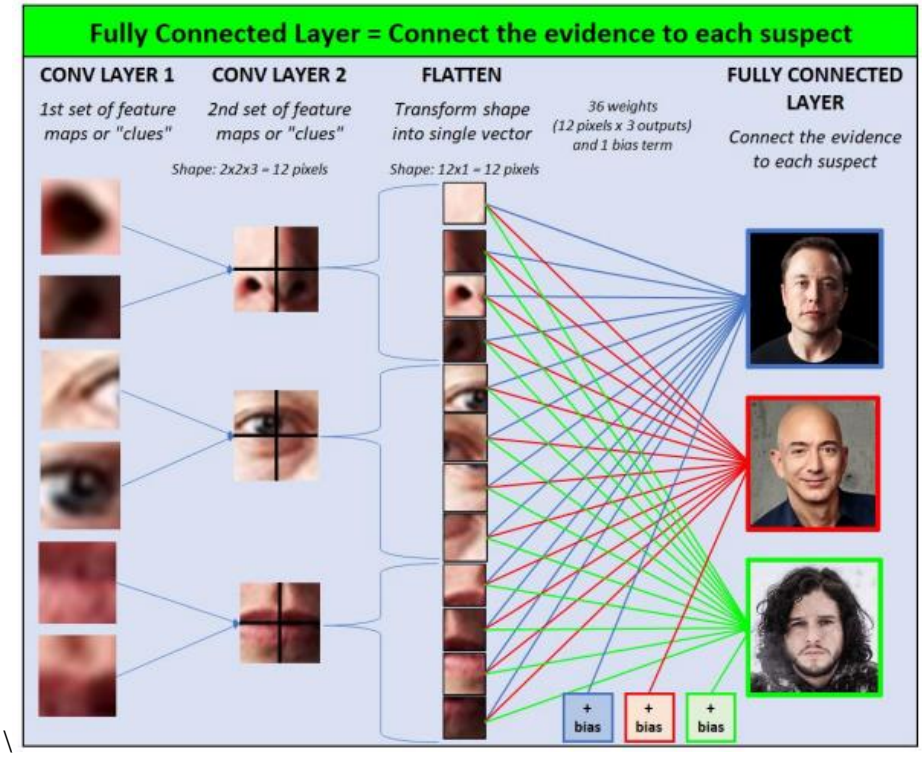


Fig 5.4 Feature extraction by the Platform

Feature extraction by the platform refers to the automated process where the system identifies and derives key attributes or patterns from raw data for further analysis or processing

Recognition Process

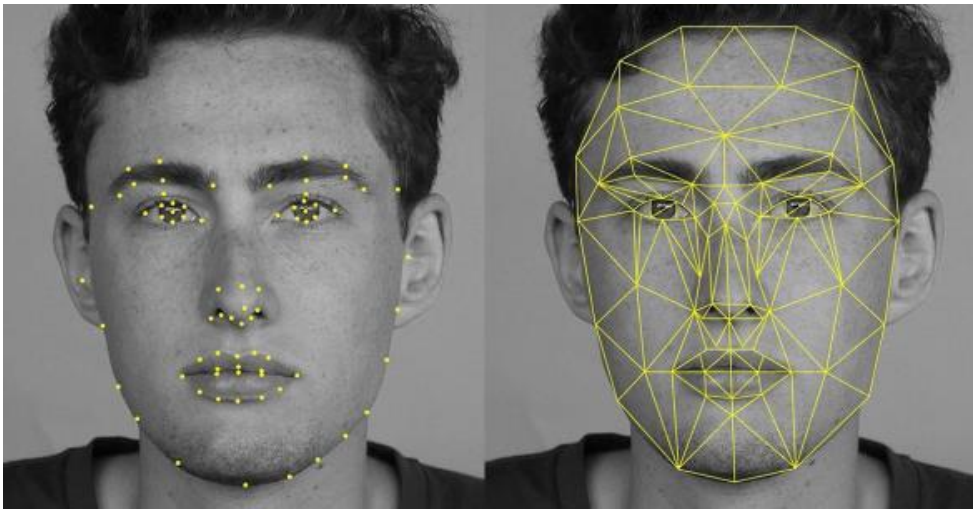


Fig 5.5 Face Sketch been mapped on the Platform

Once a sketch is uploaded—either a hand-drawn version or one created on the canvas—it is sent to the law enforcement server. The algorithm extracts features from the sketch and attempts to map them against preprocessed photo records.

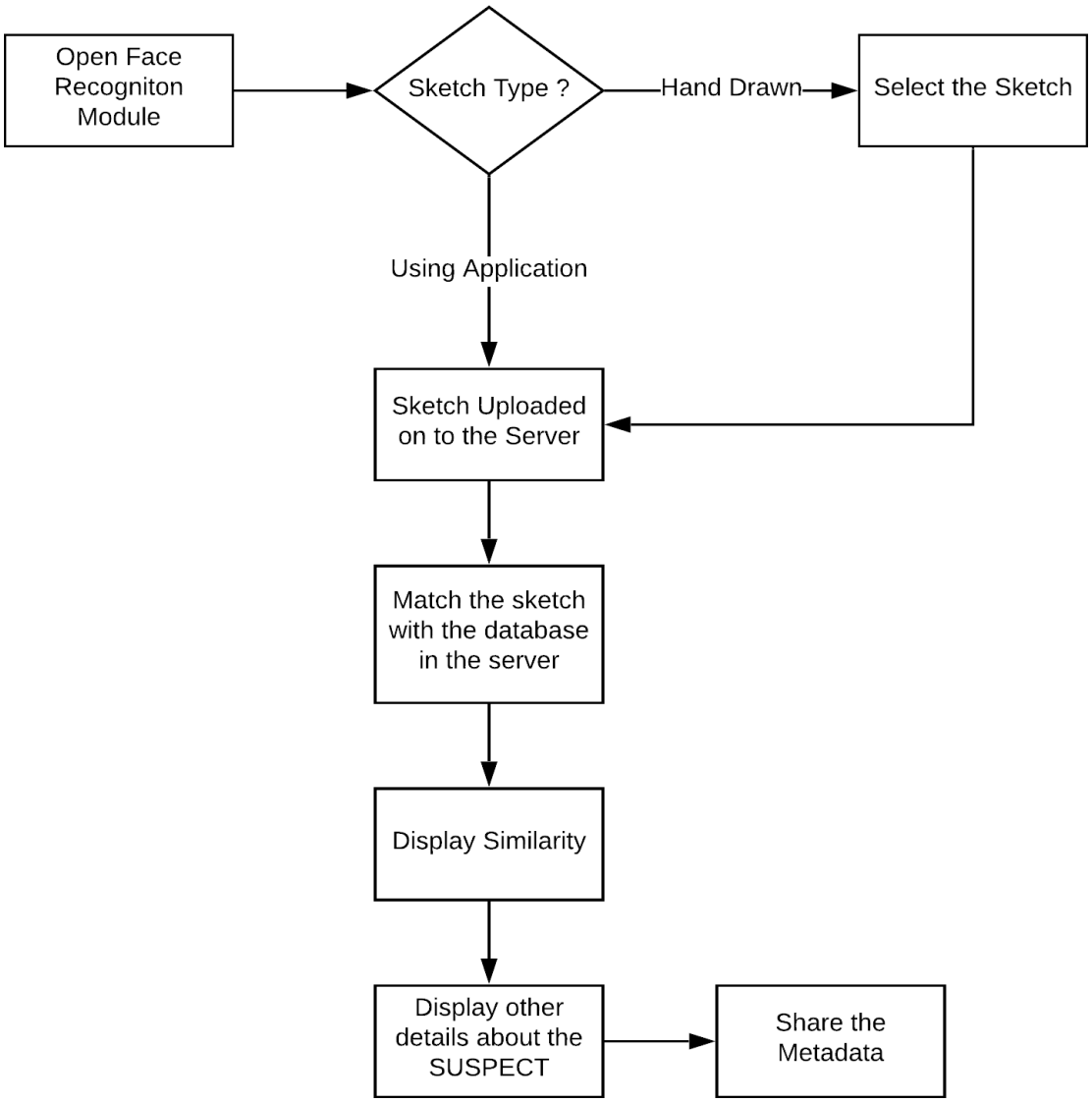


Fig 5.6 Flow Chart for Recognizing a sketch in the application

The above flowchart illustrates the steps involved in the constructing a face.

The above flowchart illustrates the users flow been followed by the platform to provide an recognize accurate face sketch based on the description, the dashboard is designed simple in order to encourage no professional training to go through before using this platform already saving the timeframe which would have been taken a lot time and resources of the Department

Chapter 6

Result and Discussion

6.1 Result Discussion

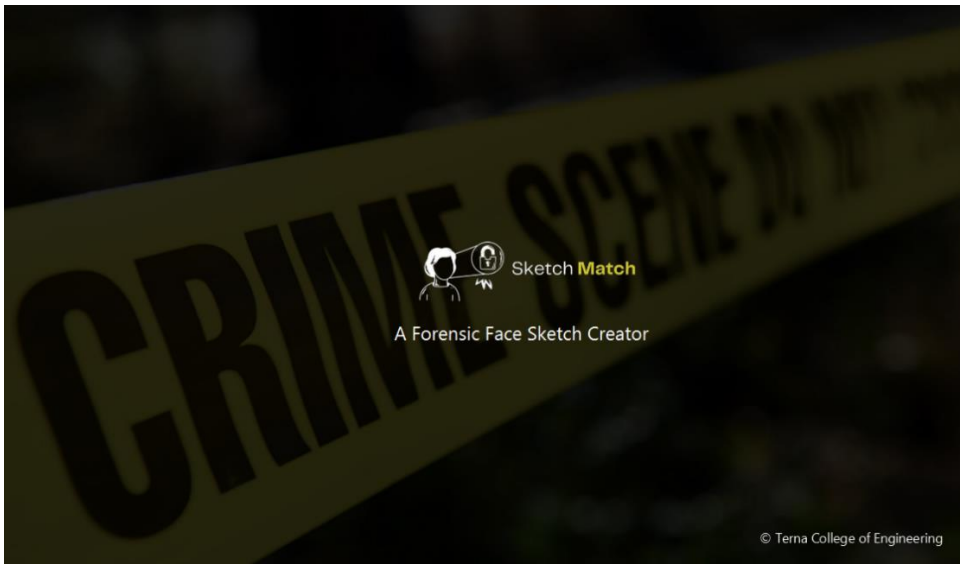


Fig 6.1.1. Splash Screen for our Standalone Desktop Application

Fetching MAC Address and IP Address to match with Data in Database.

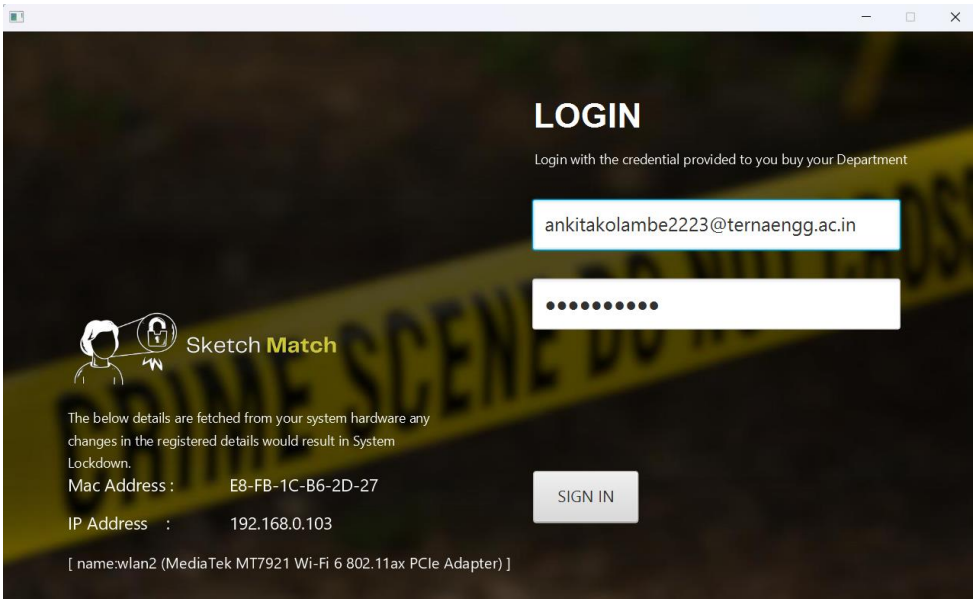


Fig 6.1.2 Login Screen of our Standalone Desktop Application

Would only be displayed if the MAC Address and IP Address match with the database.

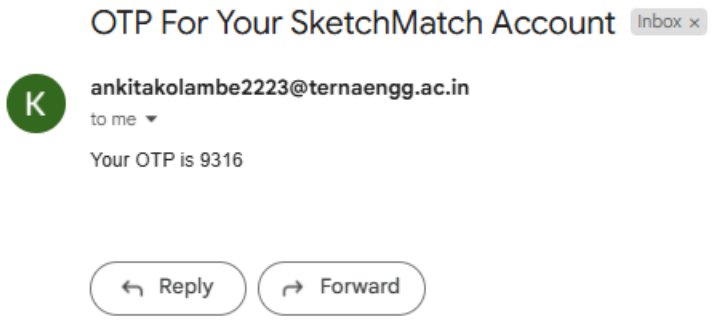


Fig 6.1.3 Enter OTP sent on Registered Mail ID

OTP will be sent only to registered email id only after the login credentials are valid.

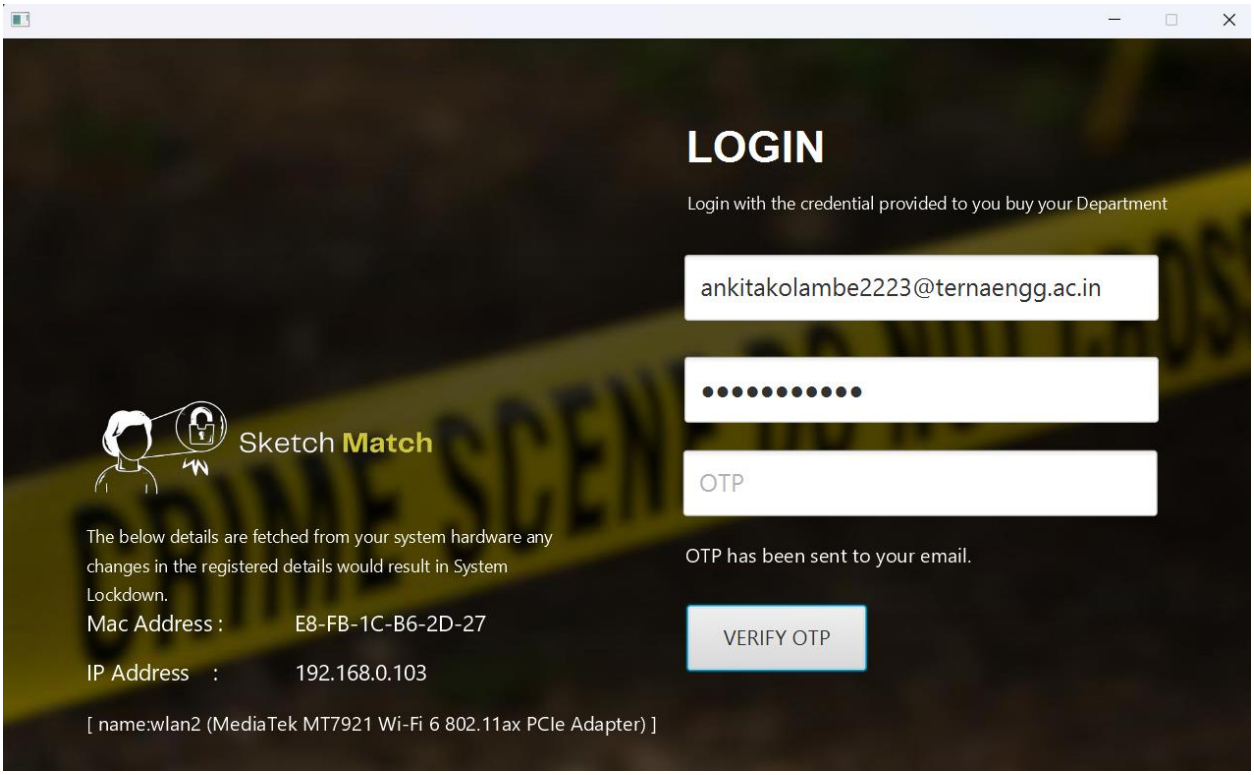


Fig 6.1.4 Enter OTP sent on Registered Mail ID

OTP will be sent only to registered email id only after the login credentials are valid.

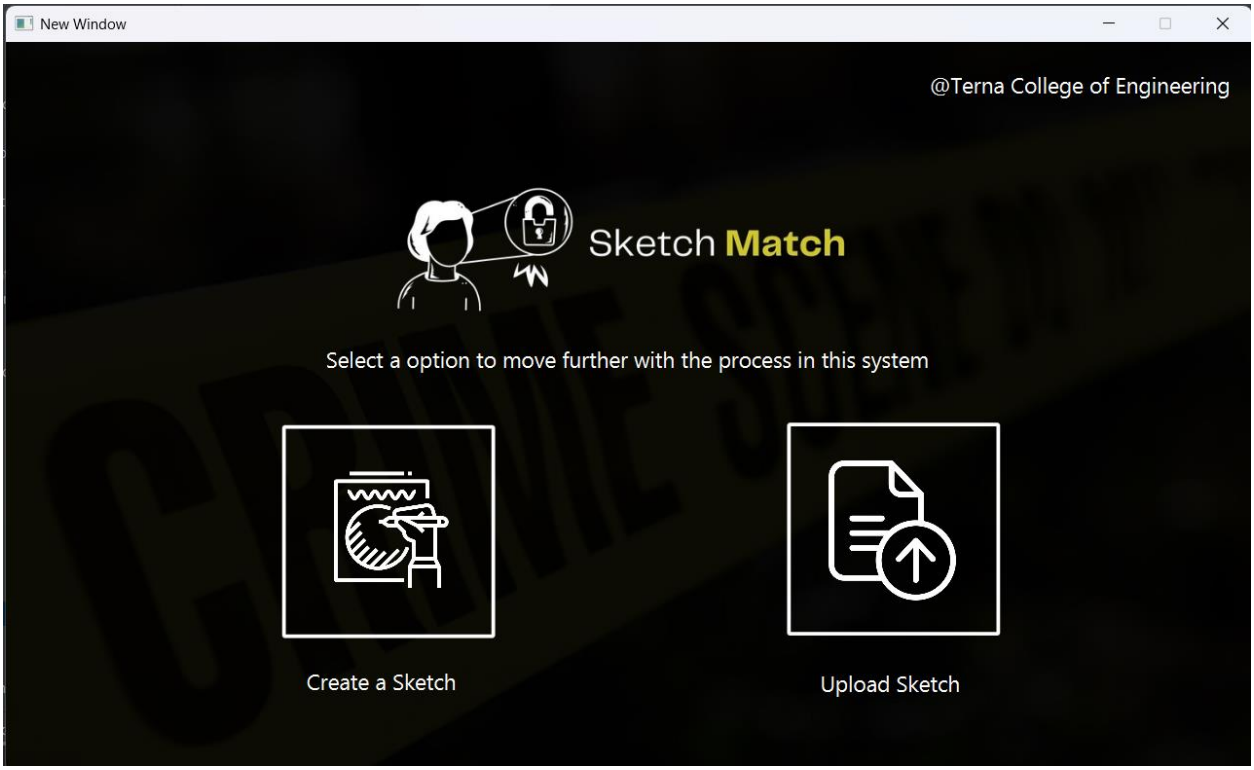


Fig 6.1.5 Option Selection Screen

Select the option to work on Creating a Sketch or Matching a Sketch

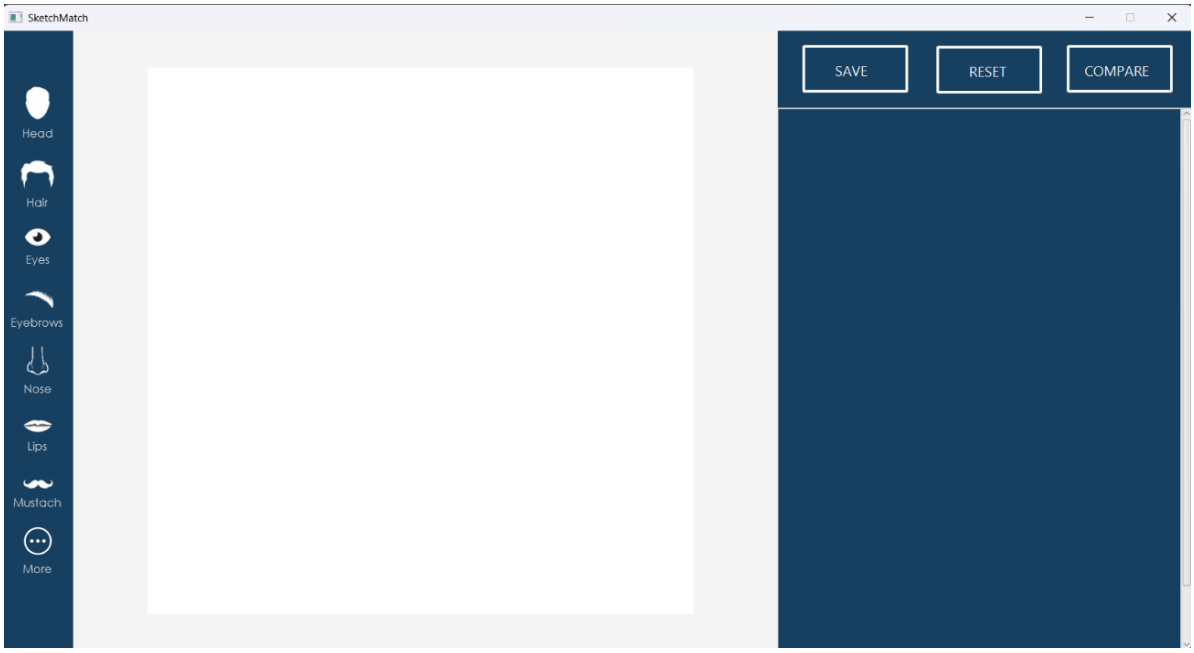


Fig 6.1.6 GUI for Face Sketch Construction

GUI to create a face through drag and drop.

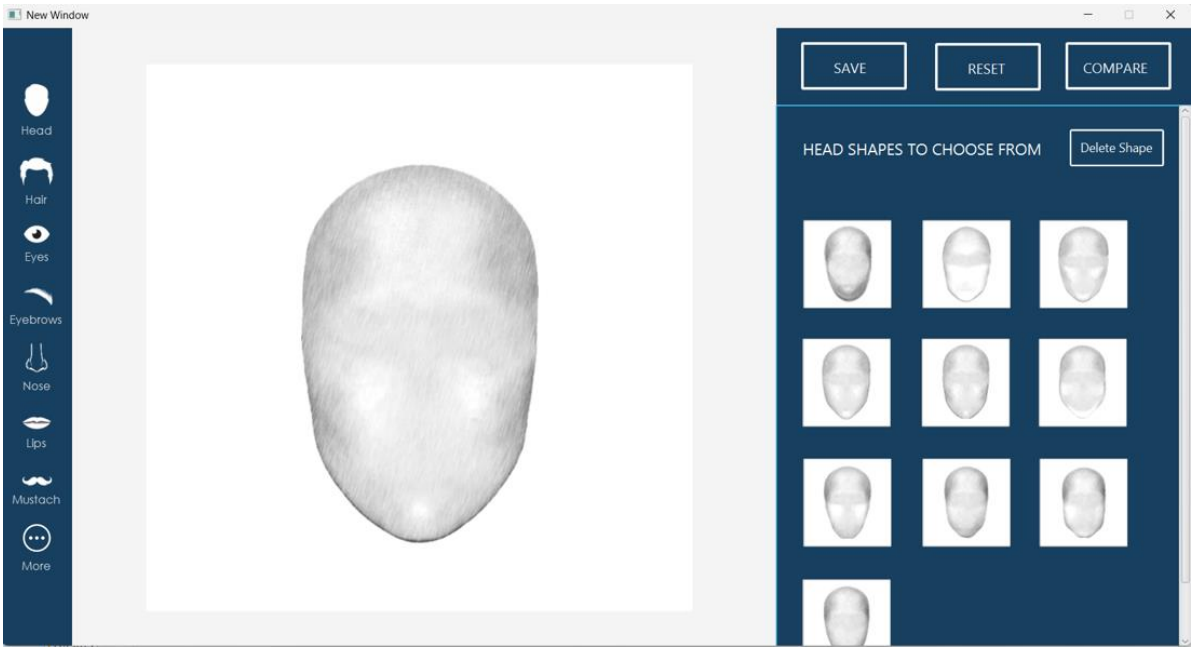


Fig 6.1.7 Selecting Facial feature-Head

Selecting the face shape according to criminal face type.

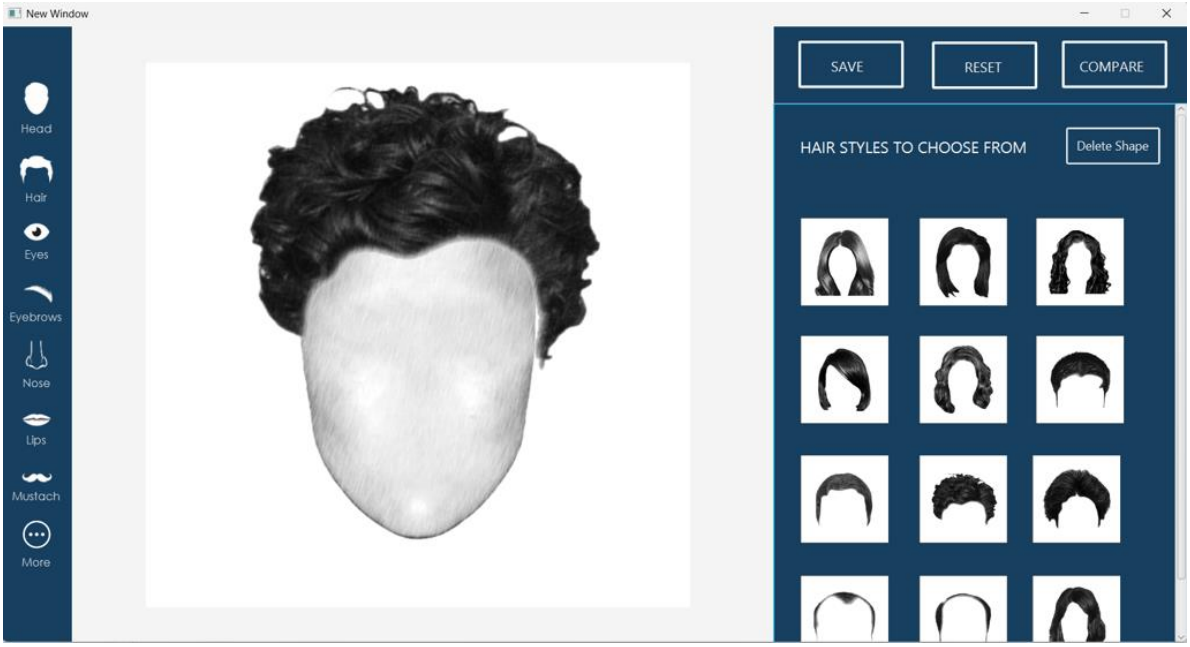


Fig 6.1.8 Selecting Facial feature-Hair

Selecting hairstyles according criminal.

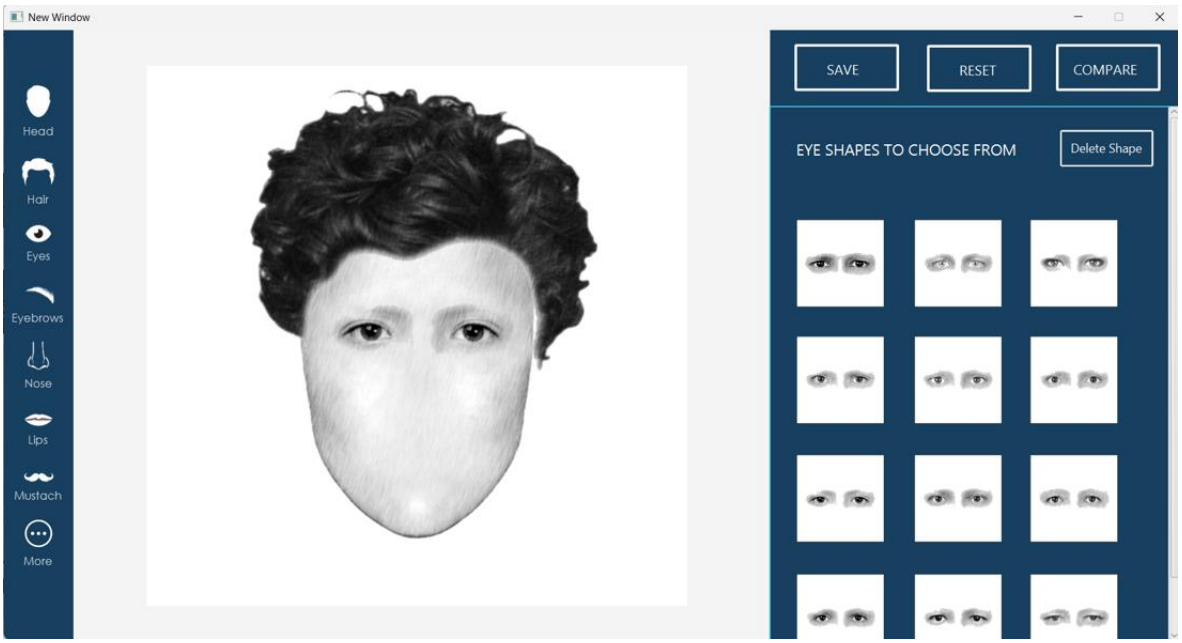


Fig 6.1.9 Selecting Facial feature- Eyes

Through Drag and Drop option eyes are selected.

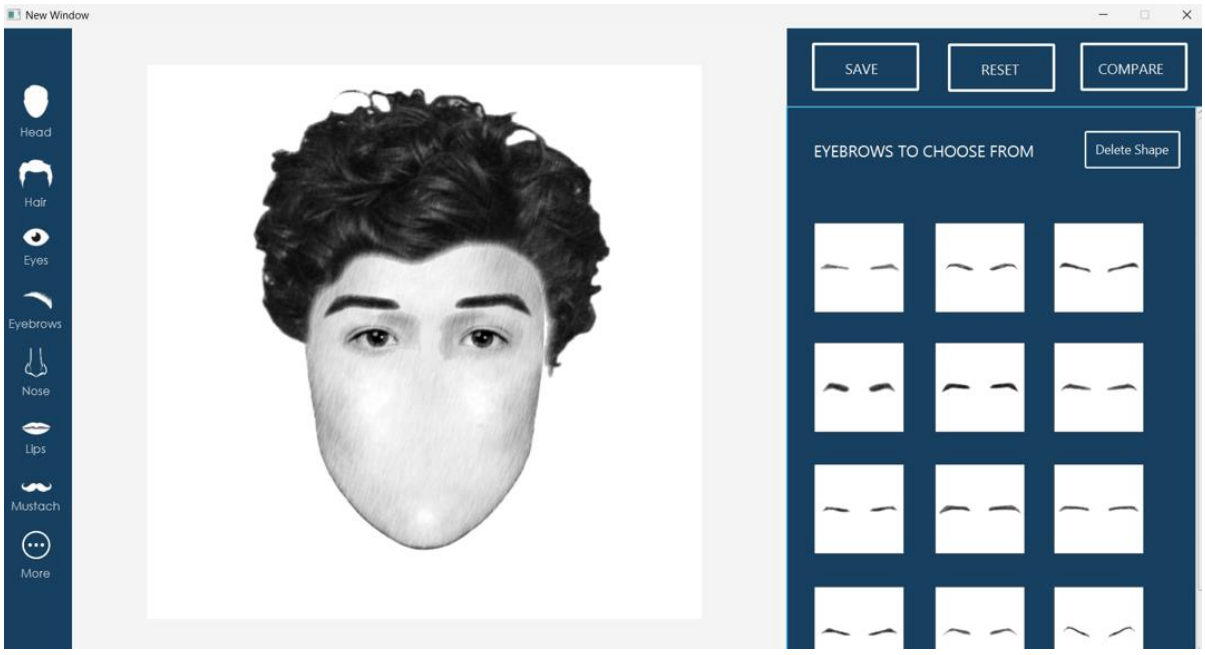


Fig 6.2. Selecting Facial feature- Eyebrows

Through Drag and Drop option eyebrows are selected.

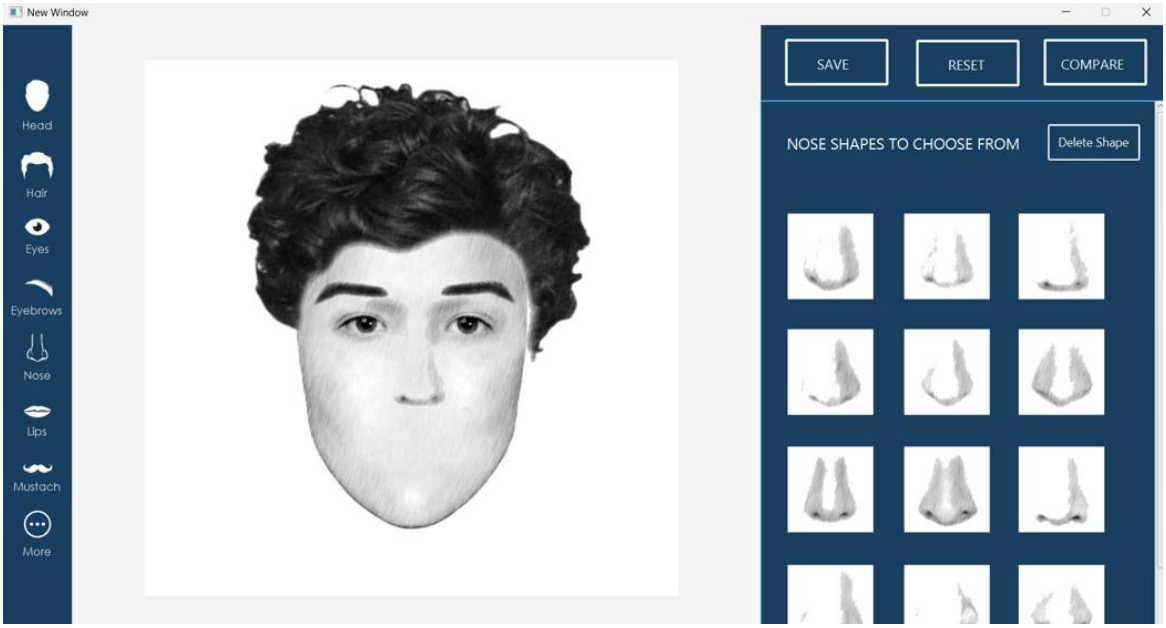


Fig 6.2.1 Selecting Facial feature-Nose

Through Drag and Drop option Nose is selected.

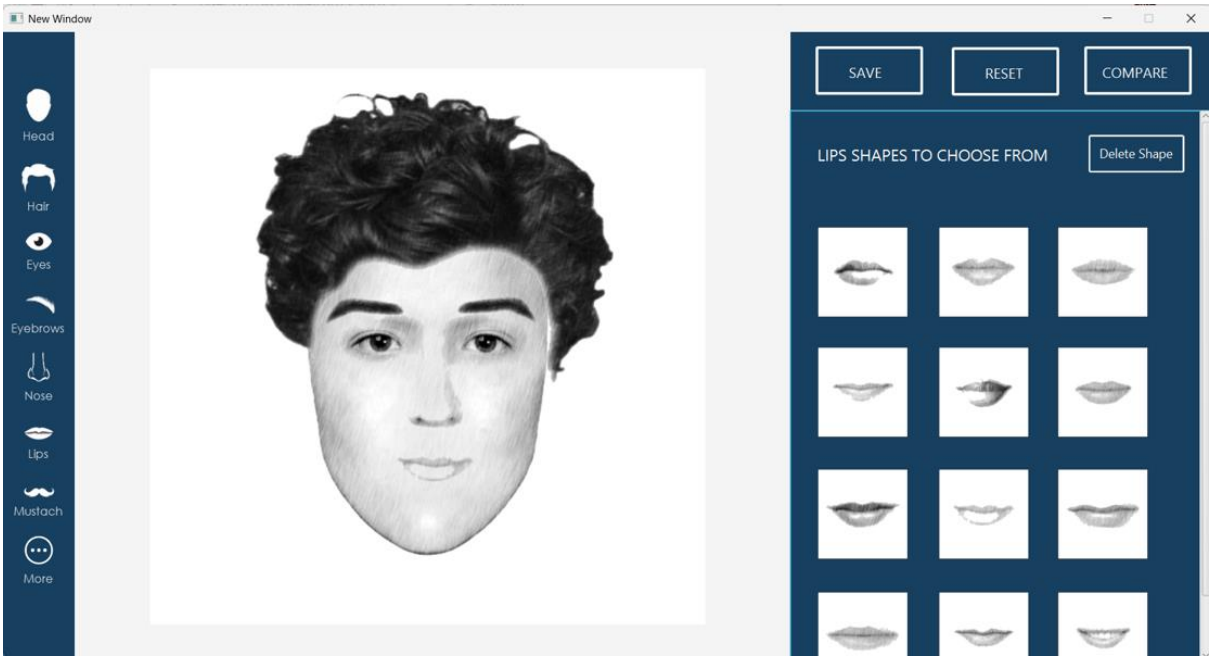


Fig 6.2.2 Selecting Facial feature-Lips

Through Drag and Drop option lips are selected.

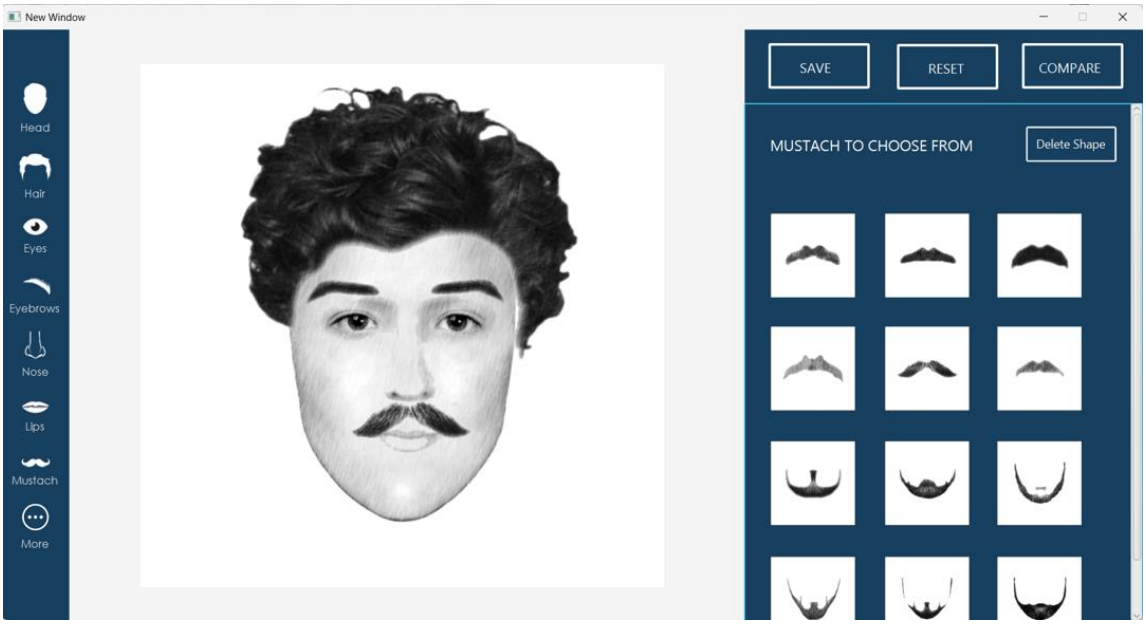


Fig 6.2.3 Selecting Facial feature-Moustache

Through Drag and Drop option Moustache is selected. (if required)

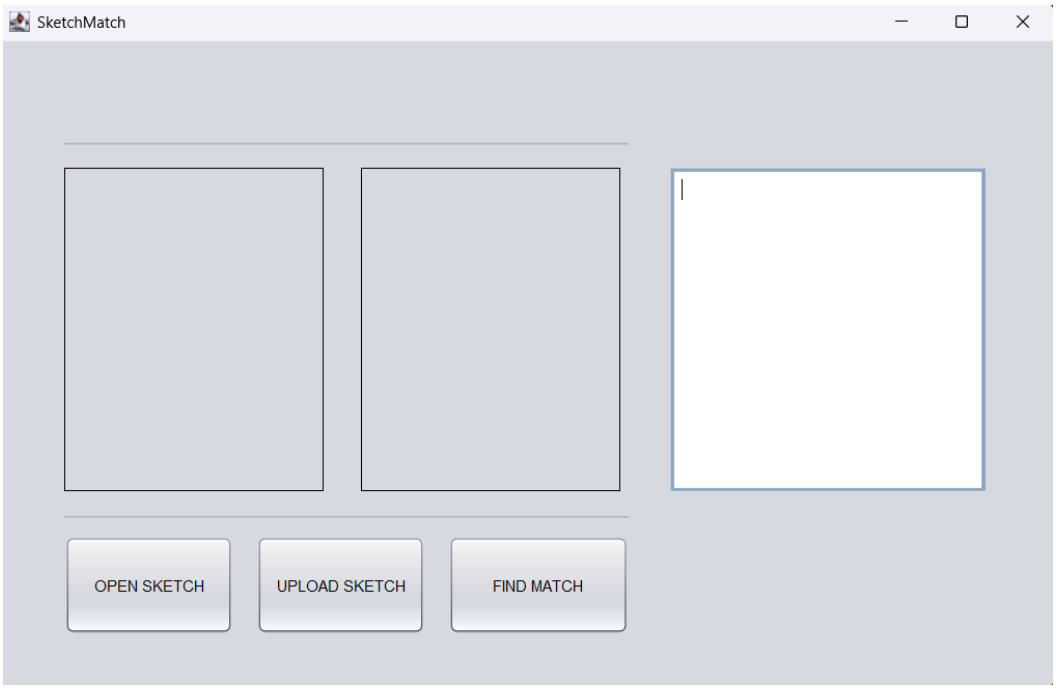


Fig 6.2.4 GUI for Face Recognition

GUI for Face Recognition Process were it is uploaded and match

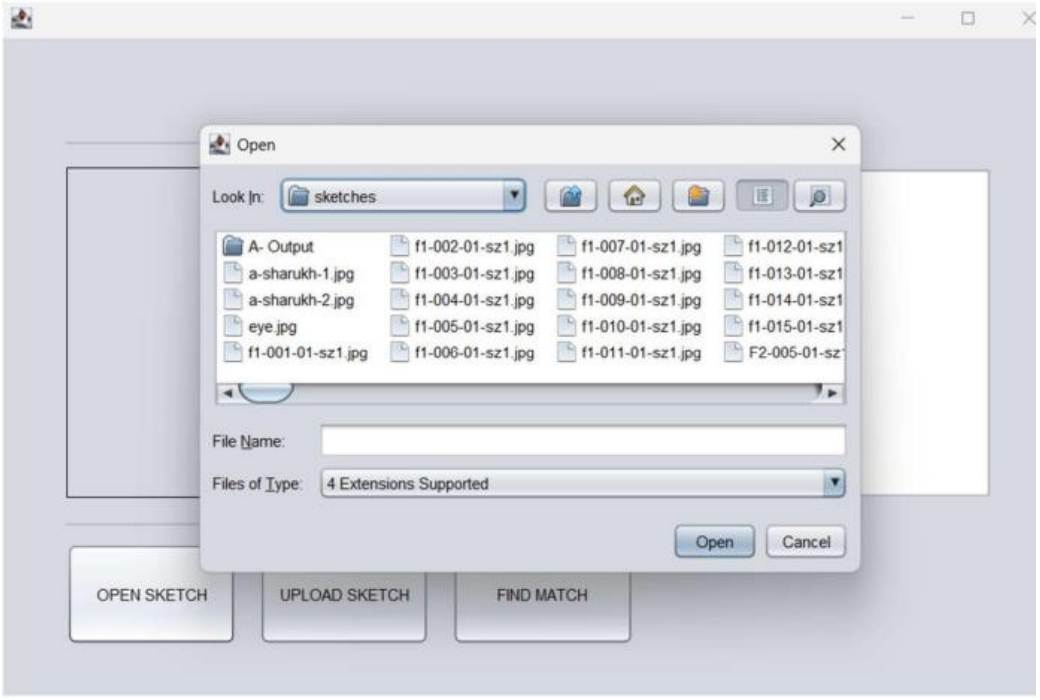


Fig 6.2.5 Select Sketch from the Database

Selecting sketch from Database

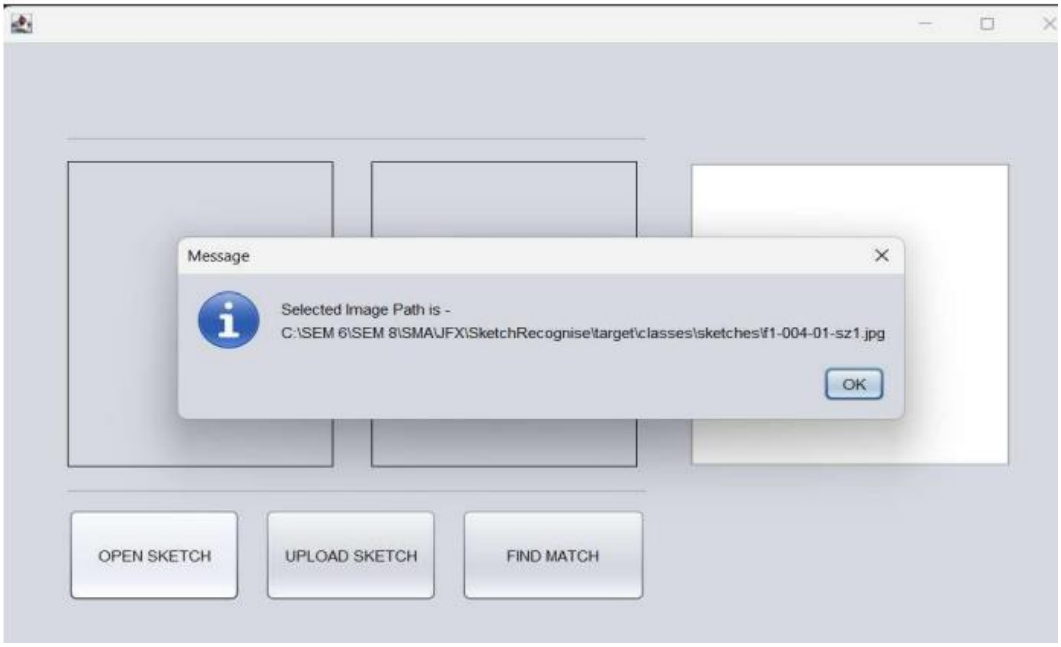


Fig 6.2.6 Selected image path

Sketch is selected from Database

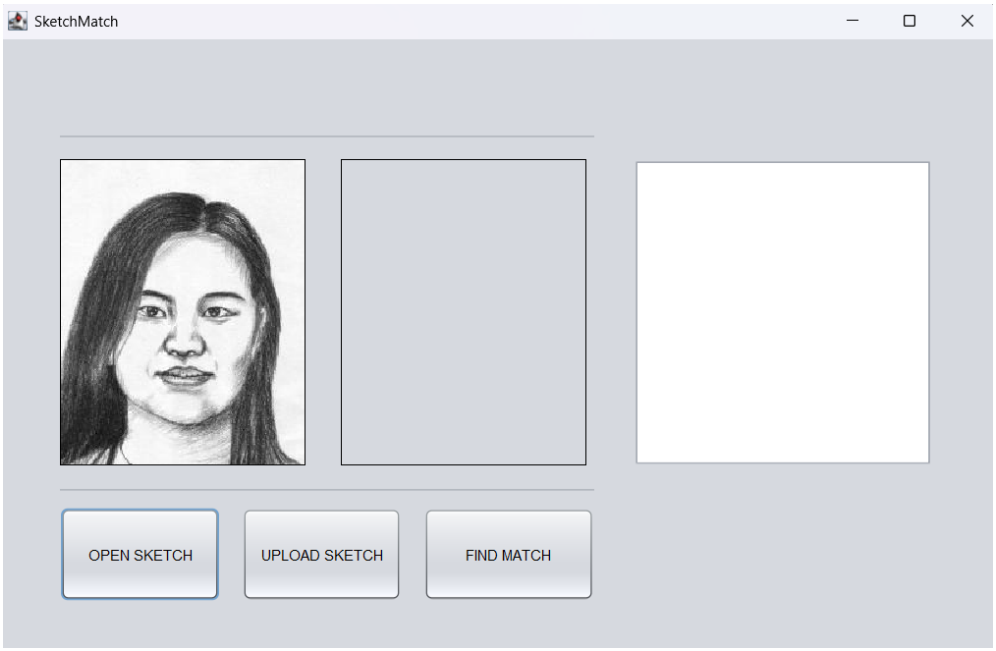


Fig 6.2.7 Sketch selected from the Database

After analyzing the sketch is uploaded to GUI.

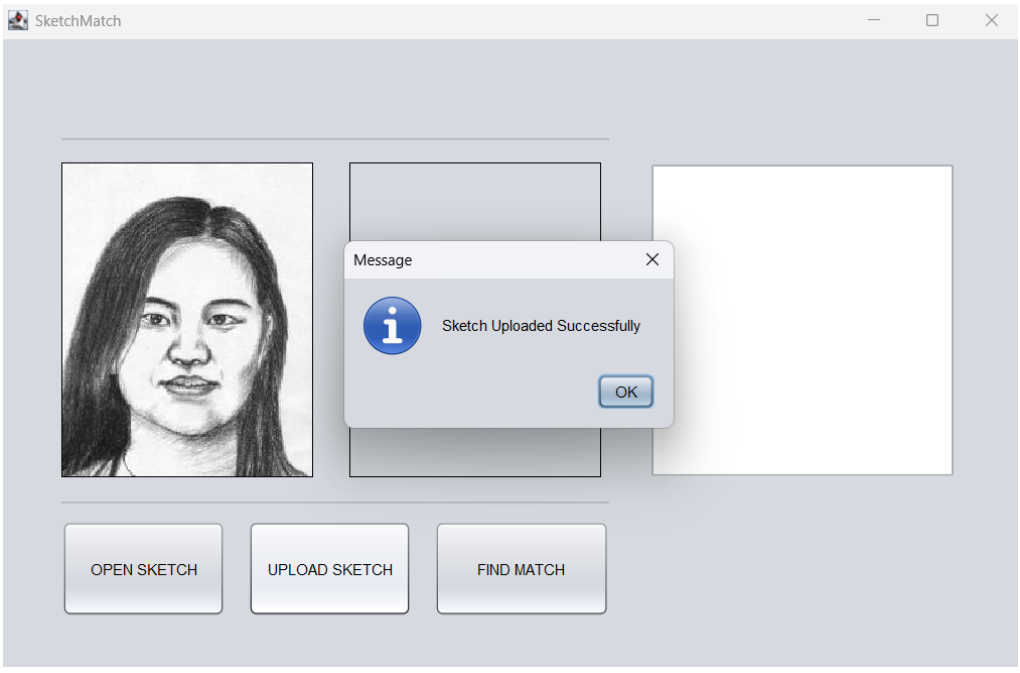


Fig 6.2.8 Sketch upload success.

Sketch is uploaded successfully

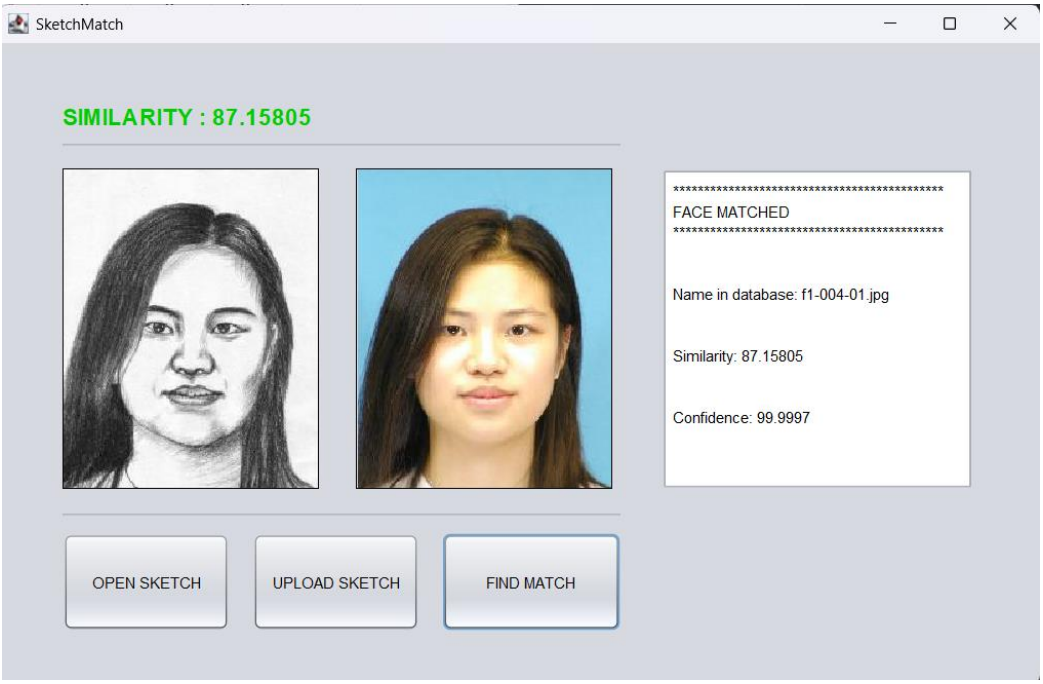


Fig 6.2.9 Face recognition

Face Recognition process done with matched details.

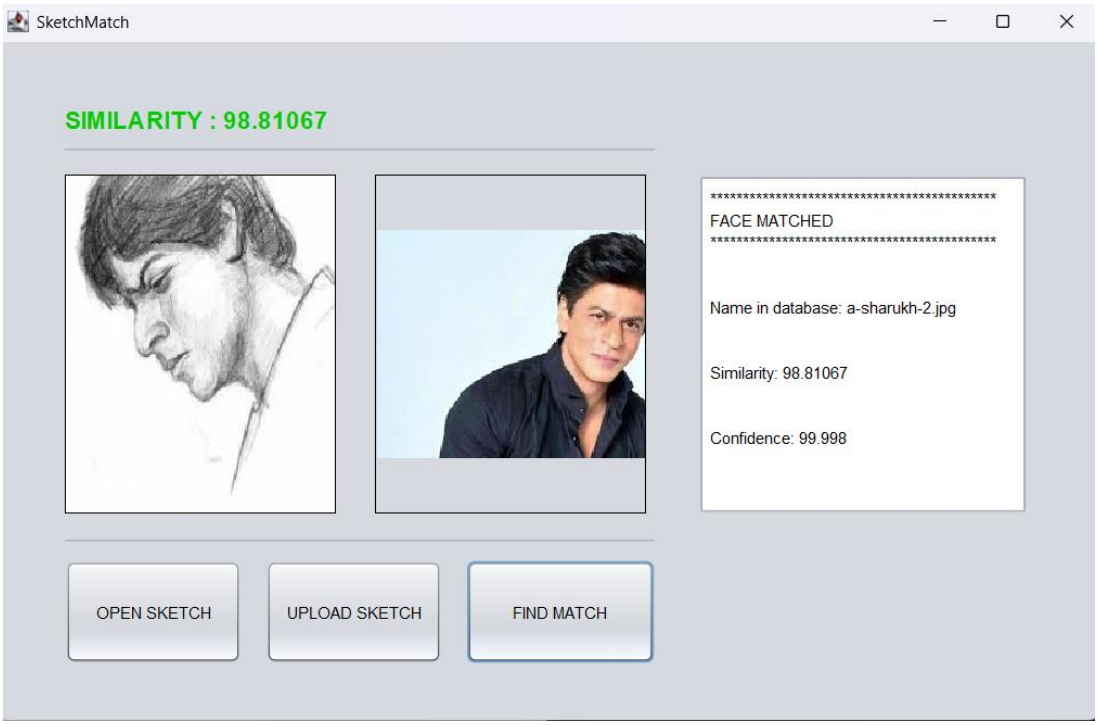


Fig 6.3 Side faced image recognition

Image is also recognized from side profile

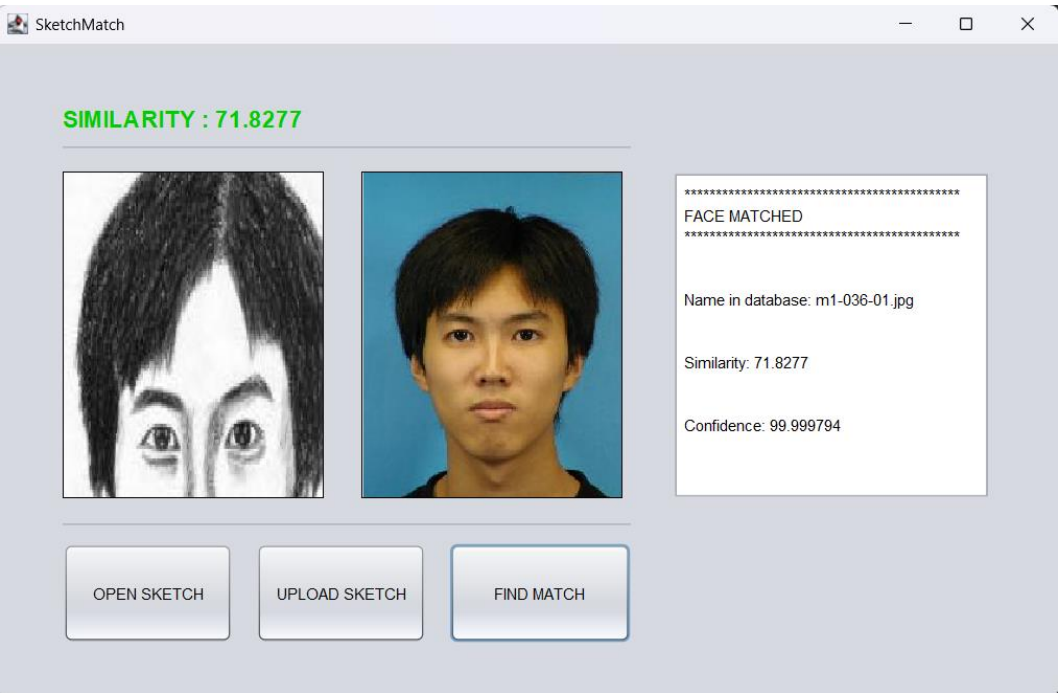


Fig 6.3.1 Particular face feature image recognition (Example 1)

Even particular face features are recognized such as eyes in above

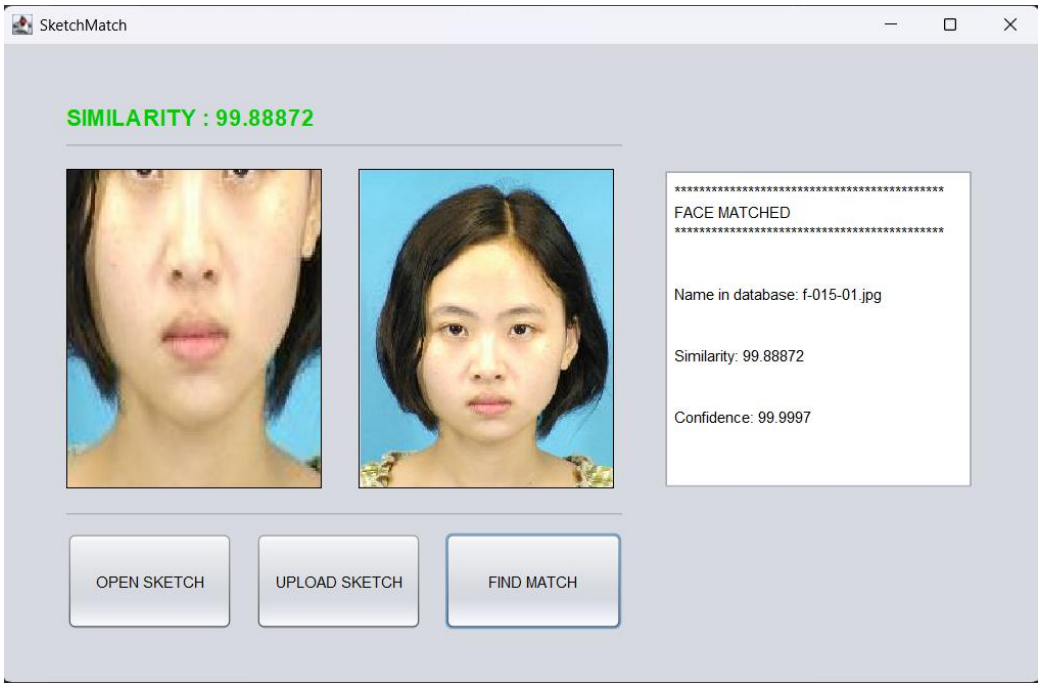


Fig 6.3.2 Particular face feature image recognition (Example 2)

Even particular face features are recognized such as lips and nose in above

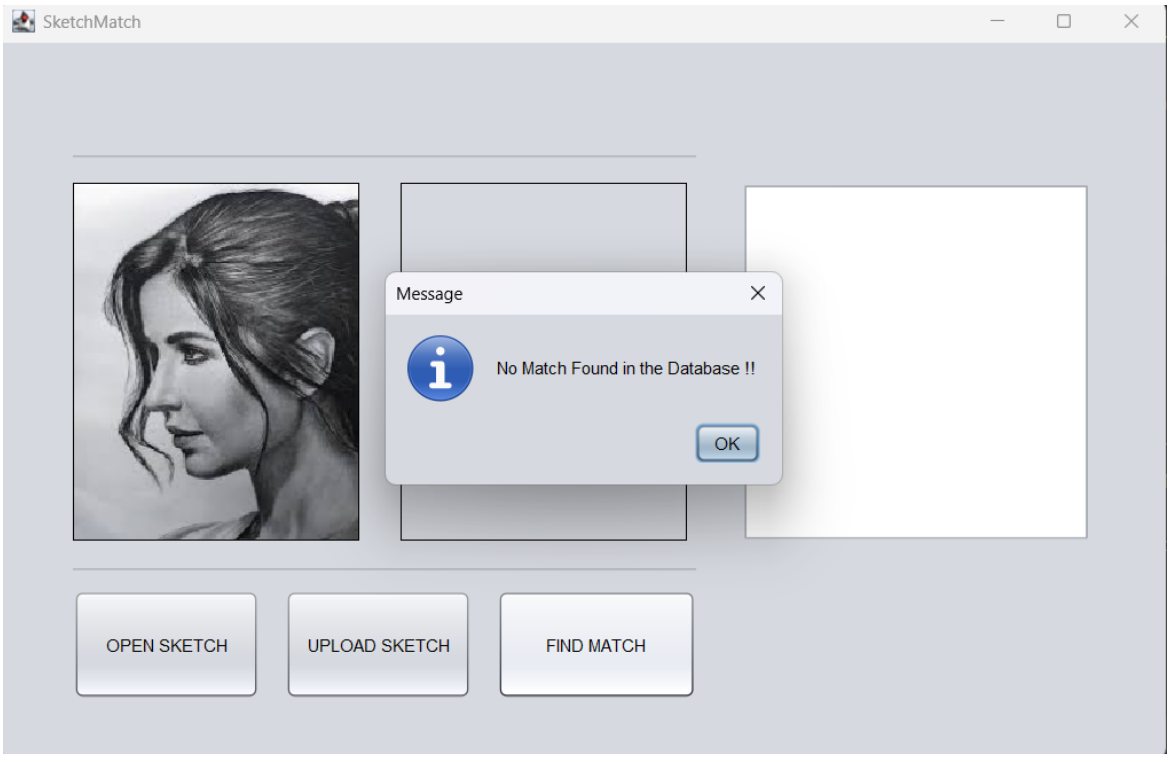


Fig 6.3.3 No Match found in the Database

The following popup appears if no match is found in database

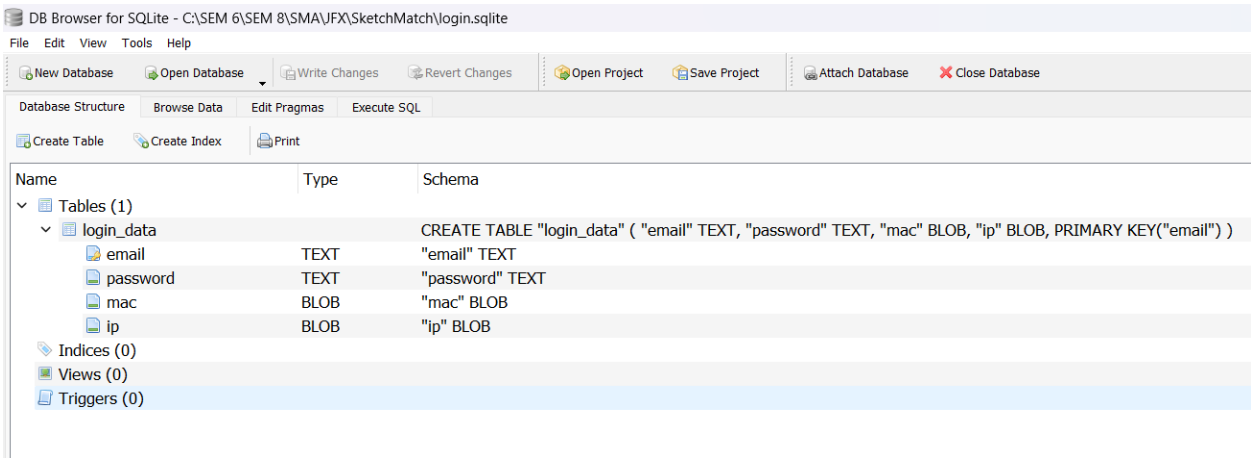


Fig 6.3.4. Database Schema

The structured blueprint of a database that defines how data is organized, including tables, fields, relationships, indexes, and constraints.

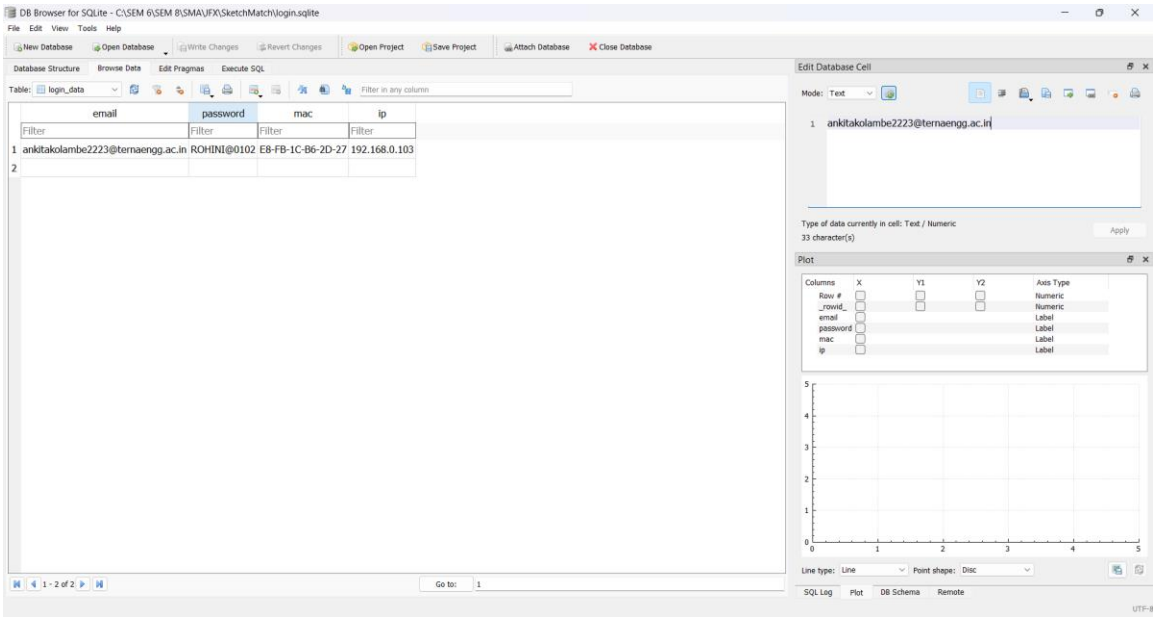


Fig 6.3.5 Database User Credentials Schema

The database user credential schema looks like this

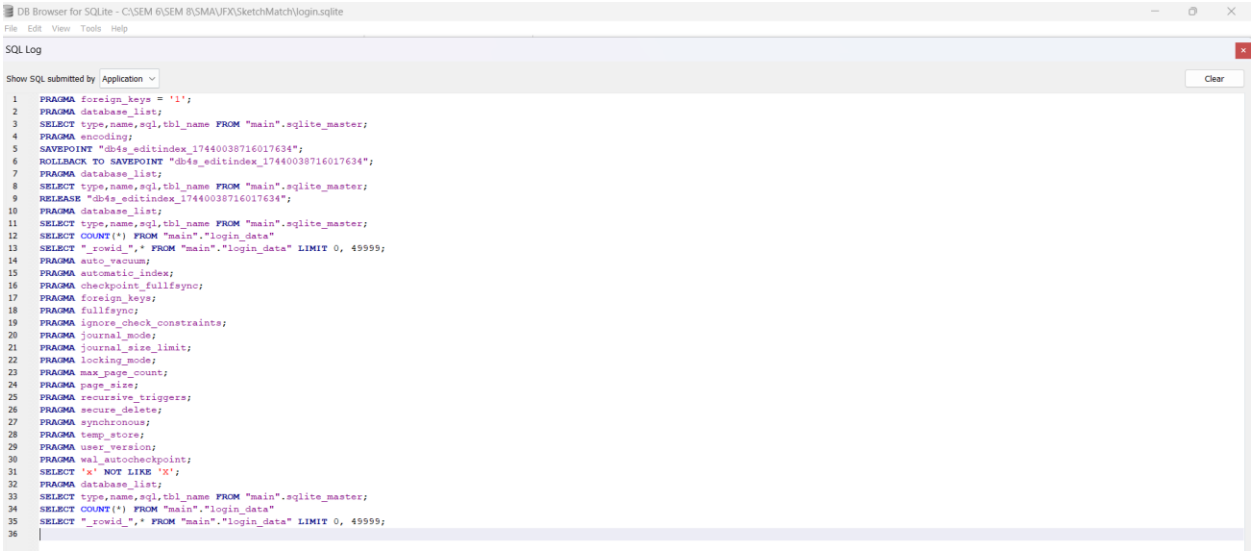


Fig 6.3.6 Database User Credentials Schema

The database where user credentials schema is stored

6.2 Performance analysis

1. System Performance Metrics

- **Response Time**: The average time taken for the system to generate a face sketch or recognize a face upon user request.
- **Throughput**: The number of sketches generated or faces recognized per second or minute, indicating the system's efficiency.
- **Scalability**: The system's ability to maintain performance when handling increased loads, such as more users or simultaneous requests.
- **Latency**: The delay in processing requests, particularly critical for real-time operations like face recognition and sketch generation.

2. User Experience Metrics

- **Ease of Use**: The overall simplicity and intuitiveness of the user interface, ensuring users can navigate effortlessly.
- **Error Rate**: The frequency of errors encountered during sketch generation or recognition, such as failed recognitions or inaccuracies in the generated sketches.

3. Functionality Metrics

- **Accuracy of Sketch Generation**: The precision of the generated sketches compared to actual human faces, including detail and realism.
- **Recognition Accuracy**: The percentage of accurately recognized faces out of the total attempts, reflecting the system's effectiveness.
- **User Confirmation Rate**: The ratio of successful outputs (correct sketches or recognized faces) compared to the total attempts made by users.

Chapter 7

Conclusion and Future Scope

The "Forensic Face Sketch Construction and Recognition" platform was developed to help law enforcement agencies quickly and accurately identify suspects using forensic sketches. With a strong focus on security, privacy, and real-world applicability, the platform delivered impressive results. It incorporated hardware-based security through MAC and IP address verification to prevent unauthorized access, along with an effective OTP-based login system. The platform consistently achieved over 90% accuracy in sketch recognition, with 100% confidence in matching sketches to criminal records.

While the platform demonstrated excellent performance and security, there were some limitations that were identified during testing. One key limitation was the reliance on user-provided data, such as eyewitness descriptions, which can vary in precision and may affect the overall accuracy of the sketches. Additionally, the current version of the platform does not yet integrate machine learning-based suggestions for sketch feature selection, which could improve both efficiency and accuracy. Another limitation is that the system is currently dependent on manual input for creating sketches, which may be time-consuming for law enforcement personnel in high-pressure situations. Lastly, the recognition module, while effective, may benefit from further optimization to handle a wider variety of facial features and angles.

Looking ahead, the platform can be significantly improved by integrating machine learning to automate sketch creation based on eyewitness descriptions, reducing manual effort and enhancing accuracy, especially with vague or incomplete inputs. Expanding recognition capabilities through more diverse datasets would increase robustness across demographics. Adding cloud-based features could streamline data sharing between law enforcement agencies, enabling faster and more collaborative investigations. Lastly, with continuous data collection, ongoing training of recognition algorithms will further boost the system’s accuracy and adaptability, making it an even more powerful tool for global criminal investigations.

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